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The Chub Mackerel (*Scomber Colias*) in the Atlantic Spanish Waters (ICES Divisions 8.c and 9.a): Biological, fishery and survey data

By

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Abstract

Atlantic chub mackerel (*Scomber colias* , Gmelin, 1978) is a middle-sized pelagic fish distributed in warm and temperate Northeast Atlantic waters. The bulk of the catches takes place in north western waters of Africa, but landing are significantly increased in the most recent years in the Iberian Peninsula, resulting a new target species for both Portuguese and Spanish purse seiner fleets which partially replaces the important drop of sardine landings in both countries.

Given this increasing importance and the lack, for the time being, of any scientific assessment, nor management plan and in order to update the available biological and catch information on this specie in Spanish Atlantic waters, this paper working document compile, review and analyze the existing data of biology, fisheries, and surveys to further enhance knowledge on chub mackerel in Atlantic Iberian waters (ICES Subdivisions 9.a South & North and Division 8.c), specifically: (i) stock structure, (ii) spatial distribution (iii) growth and reproduction and (iv) fisheries exploitation.

This analysis suggests an increasing trend in Atlantic waters (9a) in both spatial distribution and abundance, mainly due to the strength of the 2015 and 2016 cohorts. This area, besides, could be considered as a nursery area while the Cantabrian Sea (8c) is rather main spawning area. The increase of such availability is also discussed within the frame of the North East Atlantic warming.

1. Introduction

North East Atlantic (NEA) mackerel, *Scomber scombrus* (Linnaeus, 1758), and Atlantic chub mackerel, *Scomber colias* (Gmelin, 1789), are the two species of the genus *Scomber* inhabiting northeast Atlantic and Mediterranean waters (Collette, 2003). While the distribution area of NEA mackerel spreads out from the Norwegian Sea to the Gulf of Cadiz and Mediterranean waters, chub makerel, is distributed from the southern part of the Atlantic European waters (i.e. Bay of Biscay and Iberian Peninsula), towards North West African coastal waters, including Canary Islands. Besides, occasional individuals reach parts of the British Isles, the Irish Sea and the coast of Belgium (figure 1.1). It is also frequent in the Mediterranean and the southern part of the Black Sea (Whitehead et al, 1984).

Given the lack of genetic differentiation between Mediterranean and Atlantic samples, chub mackerel would form a large single panmictic population, with important gene flow between these areas (Zardoya et al. 2004).

At commercial level, the bulk of the catches are taken in Atlantic African waters, attaining 90% on average (1950-2015, FAO 2017, figure 1.2). In Atlantic European waters, landings mainly come from the Spanish and Portuguese purse seiner fisheries, generally as a by-catch with a low market prize. However, landings have increased in the most recent years in coincidence with the dramatic decrease of the

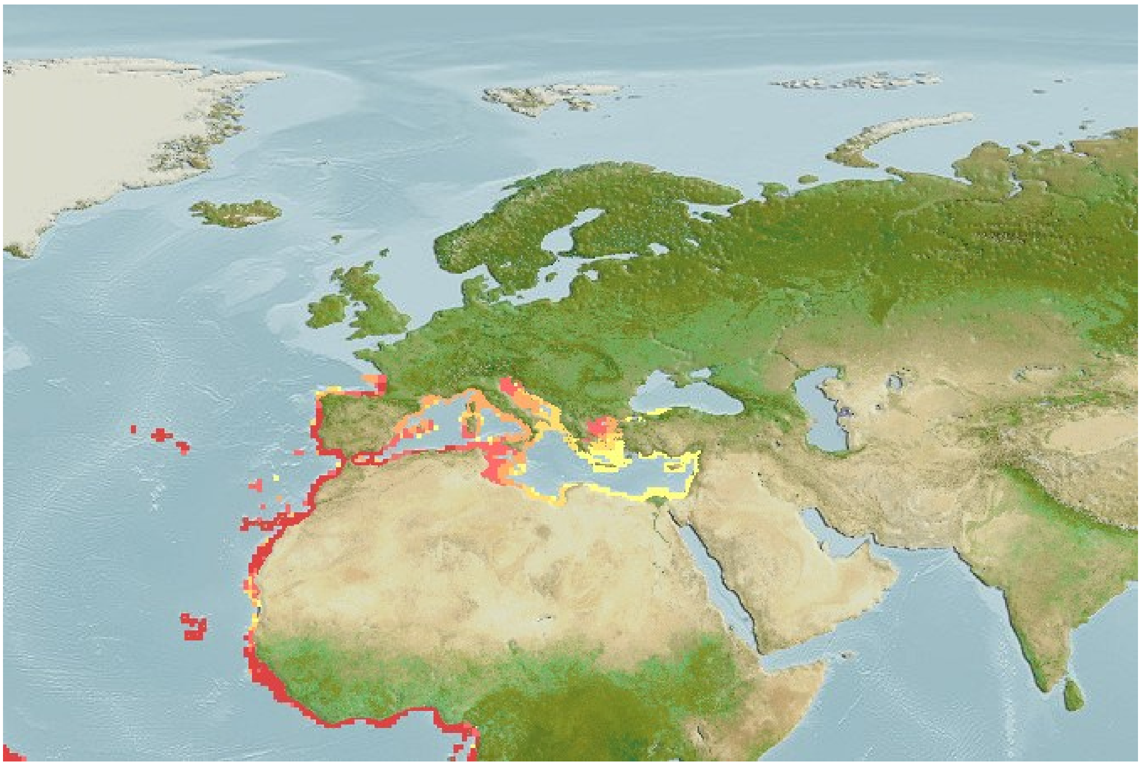

Figure 1.1. *Chub mackerel distribution. Color palette, from light yellow to red, is showing the relative probability of occurrence* (Source: Reviewed distribution maps for Scomber colias (Atlantic chub mackerel), with modelled year 2100 native range map based on IPCC A2 emissions scenario. www.aquamaps.org, version of Aug. 2016. Web. Accessed 2 Sep. 2017.)

productivity of the Atlanto-iberian sardine stock, whose landings are, at present, at the lowest historical level. According to the results derived from direct observations obtained at both acoustic-trawl and bottom trawl surveys and also from the catch sampling programs conducted in both countries, catches are mainly concentrated in the western part (ICES Division 9.a), where juveniles and younger fish are predominant, while in the Cantabrian Sea (Division 8.c) the bulk of the catches are taken in the second half of the year, being mainly adult fish, although the amount of younger fish has increased in this area in the most recent years (Martins and Cardador, 1996; Lucio, 1997)

Despite the increase of the catches in Atlantic European waters, the dynamics of this species is poorly understood. No analytical assessment is conducted, nor any scientific advice on catch levels or on biological issues has been still required. However, some studies on life traits (i.e. reproduction, growth and distribution) and also on landings and market perspectives (only in Portugal) have been recently conducted (ICES, 2015; Martins, 2007; Navarro et al., 2012; Martins et al., 2013; Navarro et al., 2014a&b; Navarro et al., 2015; Velasco et al., 2011; Canseco, 2016; Correia, 2016)

The aim of this work is to compile, review and analyze the existing data of biology, fisheries, and surveys to further enhance knowledge on chub mackerel in Spanish Atlantic Iberian waters (ICES Subdivisions 9.a South & North and Division 8.c), specifically: (i) stock structure, (ii) spatial distribution (iii) growth and reproduction and (iv) fisheries exploitation

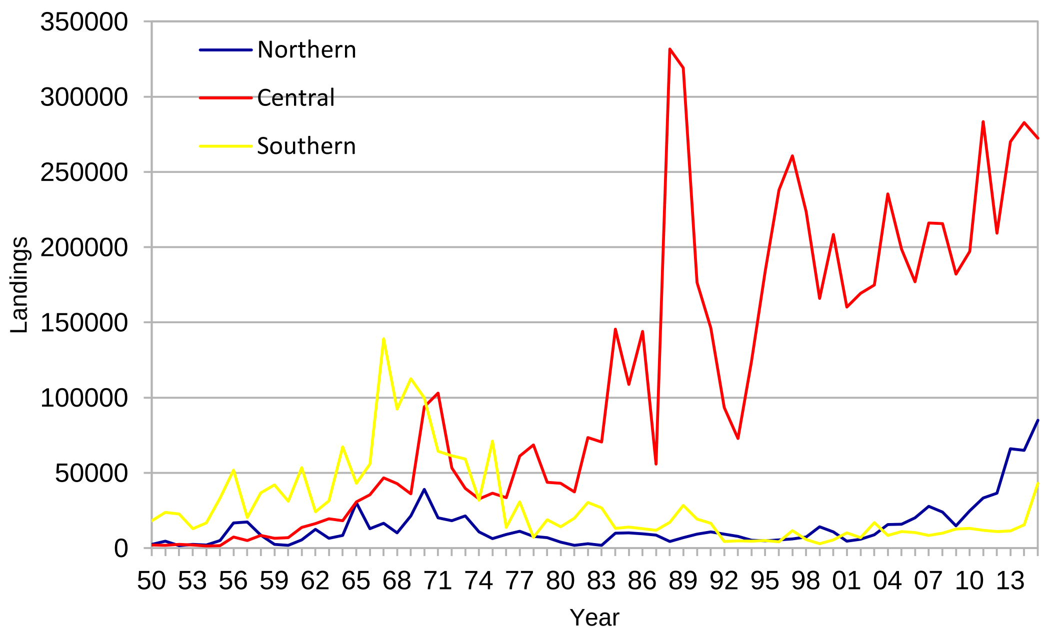

Figure 1.2. *Chub mackerel landings in eastern Atlantic waters (Northern, European waters; Central, from Mauritania to Morocco; Southern, waters south Mauritania* (Source: FAO 2017.)

2. Material and Methods

2.1 Landing Data

Yearly landings of chub mackerel from the Spanish fleet in 9a and 8c ICES Divisions for the period 1982 to 2009 are available at the ICES data base (ICES, 2010). This time series was updated with sales notes and logbooks for the period 2010-2016. On the other hand, the technical features of the vessels were taken from the official census of the Spanish fleet.

2.2 Biological Data

Biological samples from 2011 to 2016 taken in Divisions 8.c and 9.a North were analyzed. Monthly (in 2011 and 2012) and quarterly (from 2013 to 2016) samples (around 100 fish each) were selected at random from the commercial catches in each Division. Samples obtained in the spring acoustic-trawl survey PELACUS and from the autumn bottom trawl survey DEMERSALES, conducted by the IEO in this area were also used.

A total of 9920 specimens (7795 from the commercial fleet, 1788 from PELACUS and 337 from DEMESALES) were analyzed. For each of them, the following variables were recorded: total body length (TL, cm), total weight (TW, g); sex and maturity stage, determined by macroscopic examination of the gonads following Walsh et al. (1990) scale as recommended in ICES, (2015a). Besides, sagitta otoliths were removed for ageing purposes A total of 3370 gonads were dissected and weighted (Wo) and the gutted weight (Wg) of 3544 specimens was also measured. All weights were measured at 0.001 g accuracy. The age of a total of 6374 otoliths was estimated by interpreting and counting annual growth rings as described in ICES (2015b).

2.2.1 Length-weight relationship (2011-2016)

Length (TL, 1 cm length class)-weight (TW, g) relationships were estimated on a yearly and semester basis. A tool INBIO 2.0 (Estimation of biological parameters and their uncertainties by simulation techniques) developed by the IEO in R (Sampedro et al., 2005) has been used. Raw data were log-transformed in order to linearize the relationships. Parameters a and b and its coefficient of variation were estimated using the Gauss-Newton algorithm. Regression slopes were compared by analysis of variance (ANCOVA)In addition, the log-transformed *a* and the *b* parameters estimated for each relationship were plotted and a robust regression analysis was carried out in order to check any abnormal (outlier) WLR as suggested in Froese (2000) and in Froese (2006)..

2.2.2 Length Composition of Catch (2011-2016)

The catch length frequency distributions were estimated from length samples obtained at selected Spanish harbours. This activity is integrated in the Spanish biological sampling program, funded by EU under the Data Collection Framework (2009-2016).

2.2.3 Age Composition of Catch (2011-2016)

Catch-at age by quarter and ICES Division for the period 2011-2016 was obtained by applying semestral length-age keys to the catch length distributions. These length age keys came, as explained before, from samples got at both surveys and commercial fleets. A full representation of the whole catch length range was achieved. In the case of the 9.a South area, catch-at-age matrix was estimated by applying the available ALKs from the Divisions 8c and 9a N.

2.2.4 Weights-at-Age in the Catch and Stock (2011-2016)

Weight-at-age by quarter for both catches and stock were calculated for the period 2011-16.Samples obtained in the second quarter in Division 8c (both from PELACUS and commercial fleets) were used as a proxy of the weight at age in the stock

2.2.5 Maturity ogives (2011-2016)

Annual reproductive cycle by ICES Division and for the whole area was analyzed through macroscopic indexes for the period 2011-16. This analysis allowed peak spawning period be identified which, in turn, helps the uncertainty in the recognition of an immature individual from a mature individual at rest (inactive) be reduced

<u>Spawning period</u> was determined from the analysis of the monthly evolution of both the percentage of mature females (active stages) and the mean gonadosomatic index (GSI). Only potentially mature

individuals were used, i.e. individuals with length > L25. The L25 value was chosen at 25 cm, as estimated in a previous exploratory analysis which was also in agreement with previous studies (Lucio, 1997; Martins, 1996; Navarro et al., 2014a). The analysis only included only females larger than this size in order to avoid possible size-related bias due to variation in monthly length frequency distributions. For the purpose of this study, only a key of four maturity stages was used (Immature, Maturing, Active (including stages Pre-spawning, Spawning and Post-spawning of the Walsh Maturity Key) and Resting).

Individual GSI of active females >25cm were calculated using the gutted weight values:

$$GSI = Wo / Wg \times 100;$$

Wo = Gonad weight (g); *Wg* = Gutted weight (g);

Maturity ogives by length and age were constructed using only data collected during the main spawning period, when a high percentage of mature (active stage) fish was observed (March to July). Specimens collected from the spring acoustic survey PELACUS (conducted in March and April, 2011-2016) were also included in the analyses for a better representation of the immature part of the population, which is more difficult to obtain from the commercial catches.

For the estimation of maturity ogives the logistic model has been used: $p = 1/1+\exp(-(B0+B1x))$ where p is the predicted proportion of mature by age class, x is the age class, $B0$ and $B1$ are the parameter of the model to be estimated. Generalized linear model (GLM) with a binomial error distribution and a log-likelihood fit were applied with INBIO 2.0.

2.3 Fishery Independent Data: Surveys

2.3.1 Acoustic-trawl Surveys

The time series PELACUS started in 1991covering in spring time (i.e.main spawning period for the most important pelagic fish species) the northern Spanish Atlantic and Cantabrian waters from the Spanish-Portuguese border to the French Spanish one (8.c and 9.a North). The series of Spanish acoustic surveys in the ICES Sub-division 9a South (Spanish and Portuguese waters) started in its current format in 2004 for the ECOCADIZ summer survey series and in 2012 for the ECOCADIZ-RECLUTAS autumn one, although the IEO had already conducted two previous surveys in 1993 and in 2002 which only surveyed the Spanish waters of the Gulf of Cadiz.

Although the main goal of these surveys was the estimation of the sardine and anchovy abundance and biomass using the echointegration method, the inclusion of new sampling devices (i.e. new acoustic frequencies, plankton nets, oceanographic equipment and apical predators observers) together with improvements in sampling and analysis methods have allowed the pelagic ecosystem be studied, thus these surveys are routinely providing abundance estimates and spatial distribution in relation with the main oceanographic features of the whole pelagic fish community.(i.e. mackerel,*Scomber scombrus*; horse mackerel ,*Trachurus trachurus*, *T. mediterraneus* and *T. picturatus*; chub mackerel (*Scomber colias,* among others).

For the present work we have included abundance estimates and distribution f since 2013 from PELACUS (Sub-division 9.a North and Division 8.c) and since 2004 in the Gulf of Cadiz (9.a South).

The acoustic methods used in all these surveys are widely described in the ICES Acoustics and Eggs Surveys Working Group (ICES, 2016). The TS used for the chub mackerel length relationship was –68.7 dB.

Fishing stations for biological sampling and fish ID were provided by pelagic trawl hauls carried out during daytime. The location was opportunistic, accounting the echotypes observed in the echograms.

The echointegration method (Nakken and Dommasnes, 1975) was used to estimate fish abundance and biomass per specie and length group... Abundance estimates by age group were then calculated by applying the ALK from the biological sampling.. In the case of the southern acoustic surveys (ECOCADIZ and ECOCADIZ-RECLUTAS) the age structure of the estimated population has been estimated by applying the available ALKs (years 2011-2016) for the second semester from pooled commercial and surveys samples from the Sub-divisions 8c and 9a N.

2.3.1.1 Northern Acoustic Surveys (9.a North and 8.c areas): PELACUS survey

At present, only data from the 2013-17 are available. Surveys were carried out on board R/V Miguel Oliver, covering north Spanish waters in spring (i.e. mid March-mid April). Survey methodology and analysis are fully described in Carrera (2017, WD, this working group.). The analysis done for chub mackerel is the same as, for instance, mackerel or horse mackerel. Briefly, survey is conducted at 10 knots on a grid with systematic tracks with random start, 8 nmi spaced. Biomass estimates by age group (echointegration method, Nakken and Dommasness (1977) approach), distribution maps and cumulated NASC analysis were carried out.

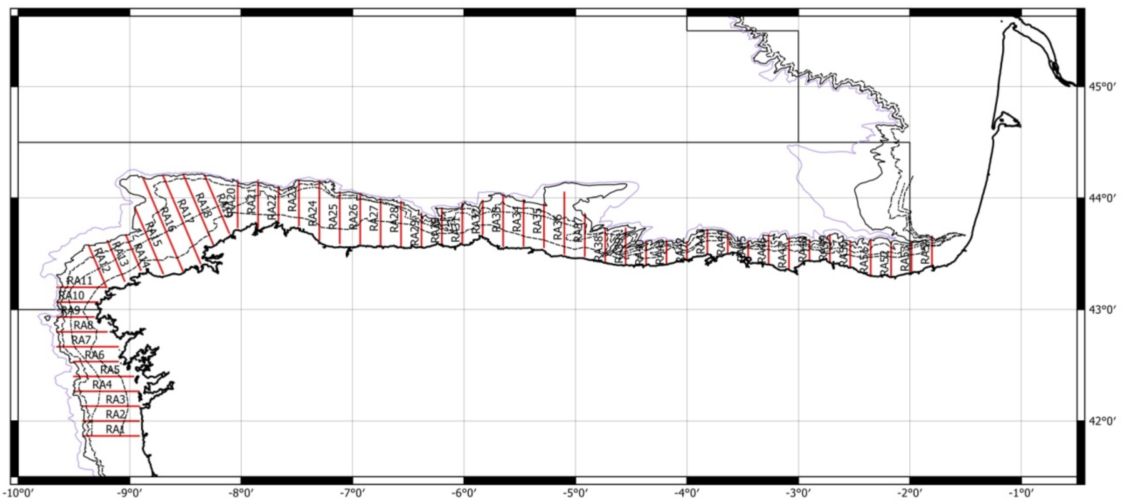

Figure 2.3.1.2.1. Surveys grid sampling for *PELACUS*

2.3.1.2 Southern Acoustic Surveys (9.a South area): ECOCADIZ surveys

The relation of surveys providing chub mackerel acoustic estimates in this area is shown in table 2.3.1.2.1.

The ECOCADIZ survey wascarried out with on board R/V *Cornide de Saavedra*, being replaced by R/V *Miguel Oliver* in 2014. The juvenile autumn survey (ECOCADIZ-RECLUTAS) is currently conducted by the IEO's R/V *Ramón Margalef*.

Survey design for both surveys consists in a systematic parallel grid with tracks equally spaced by 8 nm, normal to the shoreline, covering the whole Gulf of Cadiz (i.e. both Spanish and Portuguese waters, Figure 2.3.1.2.1).

Table 2.3.1.2.1. *ECOCADIZ* and *ECOCADIZ-RECLUTAS* surveys series. Relation of surveys providing chub mackerel acoustic estimates.

YEAR	SURVEY	DATES	R/V	SURVEY AREA	DEPTH RANGE	OBJECTIVE
2004	*BOCADEVA 0604*	06 – 13/06/04	*Cornide*	Algarve-Gulf of Cádiz	30-200 m	Ecosystem (pilot)
2006	*ECOCADIZ 0606*	18/06/ - 01/07/06	*Cornide*	Algarve-Gulf of Cádiz	20-200 m	Ecosystem
2007	*ECOCADIZ 0707*	03 – 12/07/09	*Cornide*	Algarve-Gulf Cádiz	20-200 m	Ecosystem
2009	*ECOCADIZ 0609*	26/06 – 06/07	*Cornide*	Algarve-Gulf of Cádiz	20-200m	Ecosystem
2010	*ECOCADIZ 0710*	26/07/ - 01/08/10	*Cornide*	Spanish waters	20-200m	Ecosystem (up to Cape Santa María only)
2012	*ECOCADIZ-RECLUTAS 1112*	10 – 27/11/12	*E. Bardán*	Spanish waters	7-100 m	Anchovy/Sardine recruitment (Spanish waters only)
2013	*ECOCADIZ 0813*	02 – 13/08/13	*Cornide*	Algarve-Gulf of Cádiz	20-200m	Ecosystem
2014	*ECOCADIZ 2014-07*	24/07 – 06/08/14	*Miguel Oliver*	Algarve-Gulf of Cádiz	20-200m	Ecosystem
	ECOCADIZ-RECLUTAS 2014-10	13 – 31/10/14	*R. Margalef*	Algarve-Gulf of Cádiz	20-200 m	Anchovy/Sardine recruitment (up to R19 only)
2015	*ECOCADIZ 2015-07*	28/07 – 10/08/15	*Miguel Oliver*	Algarve-Gulf of Cádiz	20-200m	Ecosystem
	ECOCADIZ-RECLUTAS 2015-10	10-29/10/15	*R. Margalef*	Algarve-Gulf of Cádiz	20-200 m	Anchovy/Sardine recruitment
2016	*ECOCADIZ 2016-07*	29/07 – 12/08/15	*Miguel Oliver*	Algarve-Gulf of Cádiz	20-200m	Ecosystem
	ECOCADIZ-RECLUTAS 2016-10	16/03 – 03/11/16	*R. Margalef*	Algarve-Gulf of Cádiz	20-200m	Anchovy/Sardine recruitment

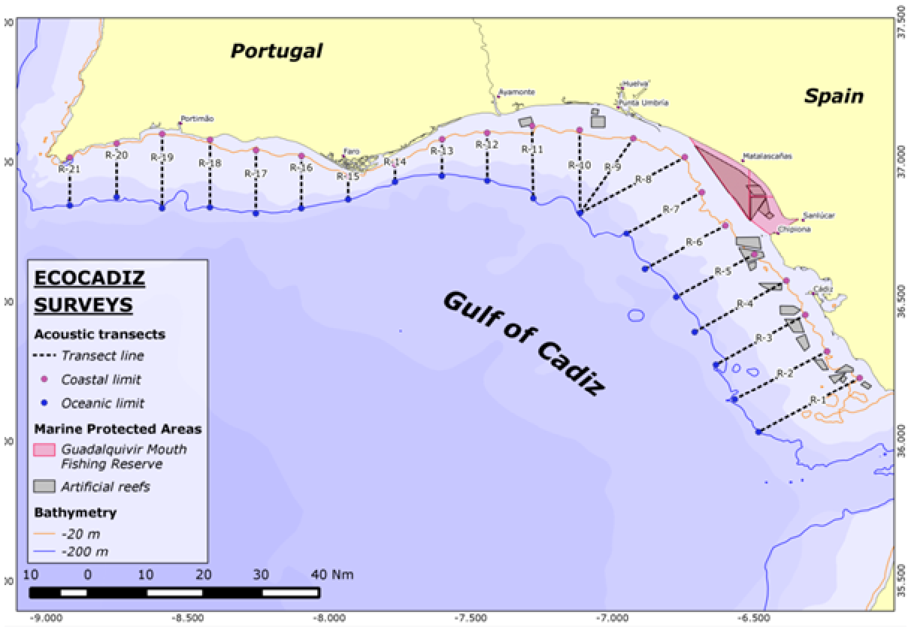

Figure 2.3.1.2.1. *ECOCADIZ* and *ECOCADIZ-RECLUTAS* surveys series: The acoustic sampling grid.

2.3.2 Bottom Trawl surveys

2.3.2.1 Northern Bottom trawl Surveys (9.a North and 8.c areas): DEMERSAL surveys

Surveys are carried out annually in autumn (between September and October), and the time series available covers from 1983 to 2016 with around 111 hauls per year (Figure 2.3.2.1.1 a) and b)), and some extra hauls to cover depths where there are few trawlable grounds.

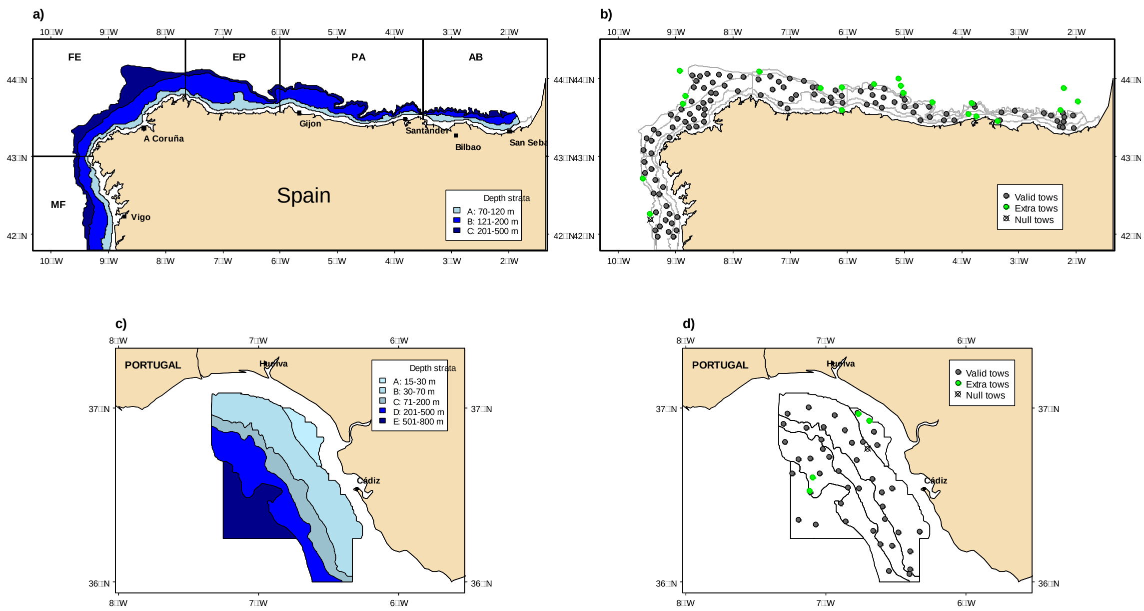

Figure 2.3.2.1.1. ***a) Stratification of the northern Spanish shelf** ground fish survey*
b) Hauls performed in the 2016 Northern shelf survey
c) Stratification of the Gulf of Cádiz ground fish survey
d) Hauls performed in the 2016 Gulf of Cádiz quarter 4 survey

2.3.2.3 Southern Bottom trawl Surveys (9.a South area): ARSA surveys

In the Gulf of Cádiz two surveys are performed every year, one in the first quarter (February-March, from 1992 up to 2016 except in 2003), and another one in the fourth quarter (November from 1997 up to 2016). The stratification of the Gulf of Cádiz groundfish surveys, based on depth is shown in (Figure 2.3.2.1.1 c). In both series around 41 hauls were performed each year covering the area and the depth range as shown in Figure 2.3.2.1.1 d, showing 2016 fourth quarter as an example of the coverage, that was lower before 2000.

3. Results

3.1 The Fishery

3.1.1 Description

According with the Spanish regulations on the fishing activity, Atlantic waters are divided in two fishing areas, the Cantabrian Northwestern area, which comprises ICES Division 8c and 9a North, and the Gulf of Cadiz (9a South). Vessels belonging to a particular area are not able to fish in the other. For those fish species subjected to a fishing regulation by TAC and quotas, fishing opportunities are individually distributed to each fishing vessel. (i.e. anchovy stocks located at both the Bay of Biscay and the Gulf of Cadiz stocks, southern and western horse mackerel stocks, NEA mackerel, BOE, 2015; BOE, 2016). For sardine, although no TAC was implemented, there is a management plan which regulates the total catches, being implemented technical measurements to regulate effort via daily landing quotas or ban period among others. No regulation on maximum allowance catches are implemented for chub mackerel although in the Gulf of Cadiz the Andalusian Administration grants temporary authorizations for the fishing of chub mackerel (BOJA, 2012). This fishing activity aims to supply the Andalusian canning industry, and their temporary authorizations are allocated both between the purse seine fleet and the trawler fleet of the Gulf of Cadiz. In the case of the last one, the vessels replace their trawl gear by a purse seine gear to develop this fishing activity seasonally.

As explained previously, chub mackerel catches have increased in the most recent period, although at market level, mean price is still lower than that achieved for other pelagic fish species. The difference in price between mackerel and chub mackerel is significant. For instance, at the Vigo auction, one of the most important European ones, the average price for chub mackerel in 2016 was 0.58 €/Kg while for mackerel was 1.24 €/Kg (APV, 2016).

3.1.2 Fleet composition

As can be seen in Table 3.1.2.1, the Spanish purse seine fleet is composed by 396 vessels, of which, 73% operate in the Cantabrian-Northwestern area and 27% in the Gulf of Cadiz. In terms of their technical specifications, both fleets do not show large differences in size (19 m CN vs. 18 m in GC), but in tonnage (63 GT vs. 32 GT) and power (210 kW vs. 150 kW).

Table 3.1.2.1 Technical features of the Spanish purse seine fleet by fishing ground in 2016.

2016	Cantabrian-Northwestern				Gulf of Cadiz			
LOA range	Nº of vessels	Size (m)	Tonnage (GT)	Power (kW)	Nº of vessels	Size (m)	Tonnage (GT)	Power (kW)
<10	26	7	2.4	20.4	0	0	0	0
10-12	20	10.9	7.4	53	4	11.6	8.1	43.4
12-18	74	14.4	19.5	101.1	60	15.7	21	112.2
18-24	76	21	62.6	213.9	38	20.9	47.6	190.8
24-40	94	29.6	140.3	383	4	24.4	72.6	306.5

>40	0	0	0	0	0	0	0	0
TOTAL	290	18.6	63.4	210.3	106	17.7	31.7	150.0

There are, however, geographic differences in technical specifications within the Cantabrian-Northwestern purse seine fleet. Vessels operating in Division 9a-North are smaller, rather similar to those from 9a-South (Gulf of Cadiz), than those operating in Division 8.c. In this way, the technical characteristics are: 17 m, 35 GT and 144 kW in Division 9a (joining the Gulf of Cadiz fleet and the Cantabrian-Northwestern fleet operating in 9.a-North), and 24 m, 96 GT and 259 kW in Division 8.c.

3.1.3 Catch Estimates (historical series, 1982-2016)

The historical series of Spanish chub mackerel landings is shown in figure 3.1.3.1. Two different periods are observed. Until 2006 catches remained at low level, except those from 1994 in 9.a. Since this year, catches have continuously increasing until 2014, remaining then at more or less the same level. This trend is similar to that observed in Portugal (Correia, 2016; Martins et al., 2010). Moreover, the increase in catches coincides with a deep decreasing trend in sardine landings. The increase in catches in both countries would be related with a higher availability together with new market exceptions for human consumption, mainly related with the canning industry. Previously, chub mackerel was not a target species for the purse seiner fleets, being a by-catch mainly used as a bait for other fisheries. (Correia, 2016).

The logbook data used to compile the 2010-2016 period provides an average of total catch around 33,000 tonnes (from 26,211 t in 2010 to 36,600 t in 2016). Although in both 8.c and 9.a catches have increased, most of the catches in the most recent peiord are taken in 9.a (57% of the total on average). The exception occurred in 2011, when catches were higher in 8.c, would be explained by the reduction of the Spanish mackerel quota due to the overfishing in 2010 (EU regulation 976/2012) that could have affected the quality of the catches of both mackerels reported in logbooks . (

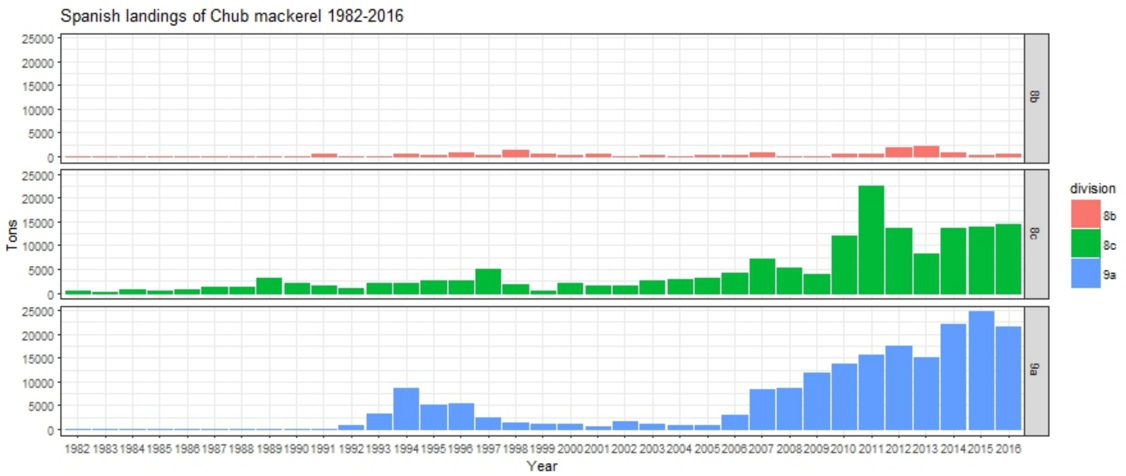

Figure 3.1.3.1. Spanish landings of Chub Mackerel (t) by ICES Division, period 1982-2016.

Figure 3.13.2 shows the quaterly distribution of chub mackerel catches. The third quarter accounts for about half of the catches of the whole year. This characteristic differs markedly from the seasonality of the other species of the Genus, *i.e.* mackerel, whose captures in Spanish waters show their peak in March and April.

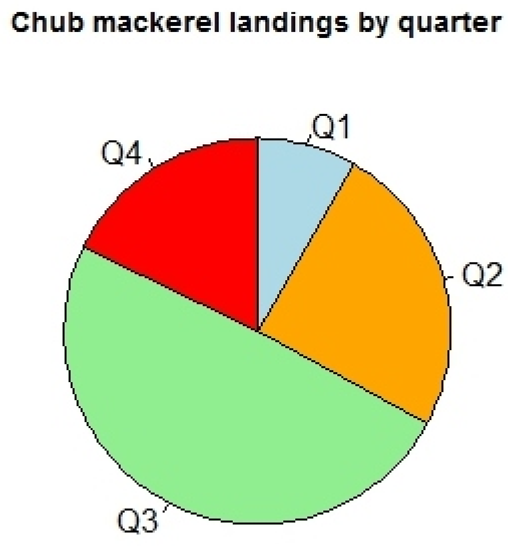

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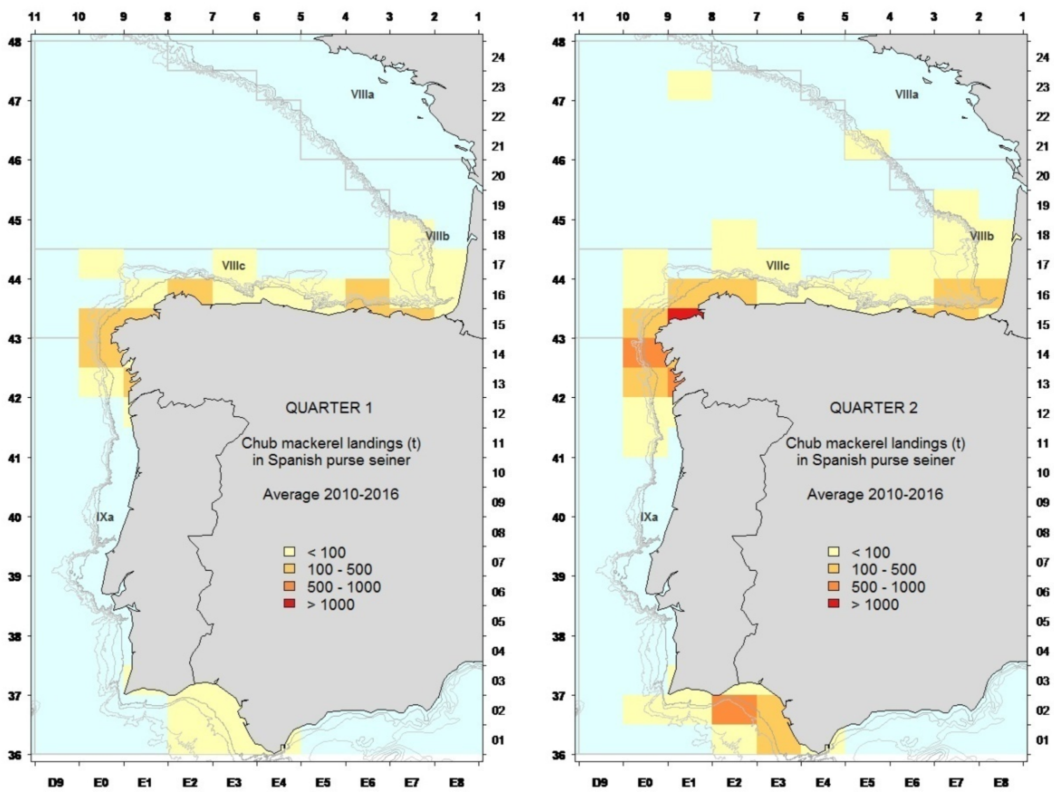
Figure 3.1.3.2. Spanish landings of chub mackerel by quarter (average 2010-2016).

3.1.4. Geographical distribution of catches

The geographical distribution of chub mackerel landings (Figure 3.1.4.1) show the highest concentrations in quarter 3 in Division 9.a, followed by the western area of Division 8.c.



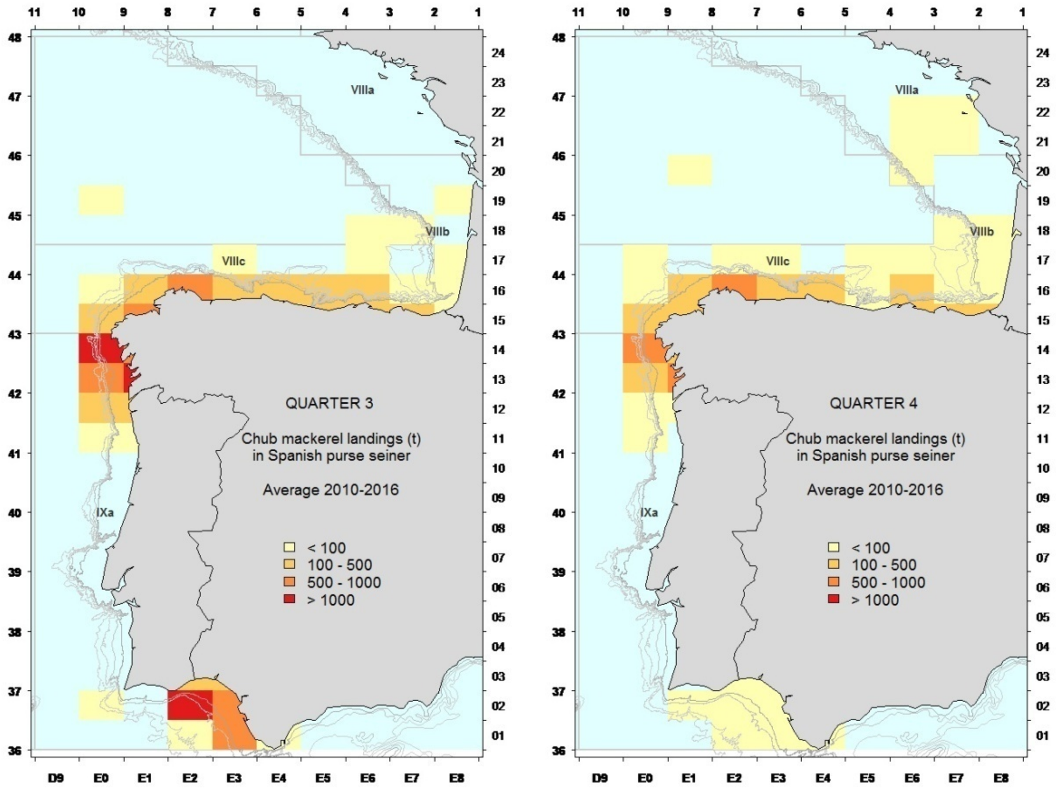


Figure 3.1.4.1 Geograhical distribution of Chub Mackerel landings (tons) by quarter.

3.1.5. Effort of the Spanish purse seine fleets

The activity of the Spanish purse seine fleet in Atlantic Iberian waters is considered a single métier within the EU Data Collection Framework (DCF): purse seine targeting small pelagic fish (acronym: PS_SPF_0_0_0). Since the DCF implementation in 2009, the "métier" has been established as sampling strata, and the sampling procedure was changed from a stock-based to a concurrent sampling, *i.e.* collecting biological information from all species caught by the vessel in a single trip.

Despite the ecological homogeneity of the "DCF métier", their trips are split according to the individual target species using multivariate analysis, as well as considering its fishing ground and fleet segment(Abad et al., 2008). This detailed segmentation is used for internal purposes and the resulting groups are called "IEO métier" (Table 3.1.5.1). As can be seen, the effort of those IEO métiers targeting chub mackerel has been duplicated in the last three years, representing 22% of the total effort in 2016.

Table 3.1.5.1. Fishing effort (number of trips) of the Spanish purse seine fleet in Atlantic Iberian waters by DCF métier and IEO métier (2010-2016).

DCF Métier	FISHING GROUND	IEO Métier	DESCRIPTION	2010	2011	2012	2013	2014	2015	2016
PS_SPF_0_0_0	Cantabrian-Norwestern	PSX11	Purse seine targeting sardine	8376	7540	7064	5127	4569	3762	4405
		PSX12	Purse seine targeting horse mackerel	8339	8934	7250	8094	6925	5187	5849
		PSX13	Purse seine targeting anchovy	2041	3727	1825	2586	3120	5046	3916
		PSX14	Purse seine targeting mackerel	1176	1091	987	813	1569	1457	1387
		PSX15	Purse seine targeting chub mackerel	3368	3986	3205	3035	5953	6322	6285
		PSX1X	Purse seine targeting other species	2480	4673	3678	3863	3708	3504	5667
		RAC11	Artisanal fleet using purse seine targeting sardine	3473	4523	3415	3472	2673	138	276
		RAC12	Artisanal fleet using purse seine targeting horse mackerel	525	325	584	501	435	746	622
		RAC13	Artisanal fleet using purse seine	12	77	159	145	49	39	20

			targeting anchovy							
		RAC14	Artisanal fleet using purse seine targeting mackerel	41	14	17	4	48	26	30
		RAC15	Artisanal fleet using purse seine targeting chub mackerel	114	142	65	71	287	193	226
		RAC1X	Artisanal fleet using purse seine targeting other species	131	64	198	182	312	175	228
	Gulf of Cadiz	PSX21	Purse seine targeting sardine	4739	5245	4449	4243	3635	1364	1975
		PSX22	Purse seine targeting anchovy	3189	3893	3410	5328	5164	5593	4851
		PSX23	Purse seine targeting mackerel	127	122	103	104	41	238	107
		PSX24	Purse seine targeting chub mackerel	564	936	1329	1048	1121	1827	1830
		PSX2X	Purse seine targeting other species	379	334	452	434	587	760	882
TOTAL				39074	45626	38190	39050	40196	36377	38556

3.2 Biological Data

3.2.1 Length-weight relationship (2011-2016)

Length-weight relationships (LWRs) of chub mackerel (sex combined) by semester and year (time series 2011-16) were calculated for pooled data. The number of specimens processed, length range (cm), parameters *a* and *b* of the LWRs and CVs can be seen in Table 3.2.1.1. The overall results are shown in Figure 3.2.1.1 and Table 3.2.1.1. Annual LWRs lined up exponentially. Also a logarithmic transformation was used to express these relationships, using a linear regression (Figure 3.2.1.2). No significant differences (*F*-test; $F_{5\text{-}59} = 0.58$; $P > 0.1$) in the slopes (coefficient *b*) of annual relationships were found.

The b values of the chub mackerel (sex combined) estimated for each year ranged from 3.137 (CV=0.005) in 2013 to 3.568 (CV=0.01) in 2011. On the other hand, if data are split in semesters, b values ranged from 2.953 (CV=0.012) in 2014 to 3.401 (CV=0.014) in 2016 for the first semester, and from 3.029 (CV=0.019) in 2016 to 3.548 (CV= 0.007) in 2011 for the second one (Table 3.2.1.1 and Figure 3.2.1.1). Most of the values of b were above 3. The lowest value (below 3), was estimated in the first semester of 2014. In 2012 (both semesters) and in the second one of 2016 b values were close to 3. The allometric value of *b*, , was higher (above 3.40) in 2011 and 2016. No trend was observed in the values of b, although being more fluctuating in the first part of the year (Figure 3.2.1.2).

A regression analysis of log a over b did not find any outlier (p=0.000) and its linear regression explains 99% of the variance. Therefore all the data here estimated can be used for the analysis (Figure 3.2.1.3).

Table 3.2.1.1. Relationship between W (Total weight, g) and TL (Total length, cm) of chub mackerel, from commercial fleet and surveys sampling, 2011-2016.

YEAR	TOTAL- SEX COMBINED Commercial Fleet&Surveys					SEMESTER 1- SEX COMBINED Commercial Fleet&Surveys					SEMESTER 2- SEX COMBINED Commercial Fleet&Surveys				
	Parameter		CV	Lmin-Lmax	n	Parameter		CV	Lmin-Lmax	n	Parameter		CV	Lmin-Lmax	n
2011-2016	a	0.003	0.037	11.2-50.8 cm	10163	a	0.003	0.055	14.6-50.8 cm	5800	a	0.005	0.043	11.2-49.5 cm	4363
	b	3.267	0.003			b	3.276	0.005			b	3.163	0.004		
2011	a	0.001	0.124	12.7-48 cm	2077	a	0.002	0.107	19.2-48 cm	1250	a	0.001	0.082	12.7-41.8 cm	827
	b	3.568	0.01			b	3.353	0.009			b	3.548	0.007		
2012	a	0.004	0.081	14.7-46.9 cm	2397	a	0.007	0.143	16.6-46.9 cm	1300	a	0.007	0.075	14.7-46.5 cm	1097
	b	3.201	0.007			b	3.035	0.013			b	3.092	0.007		
2013	a	0.006	0.055	19.1-50.8cm	2012	a	0.002	0.091	19.1-50.8cm	863	a	0.008	0.064	22-43.8cm	1149
	b	3.137	0.005			b	3.393	0.008			b	3.037	0.006		
2014	a	0.004	0.143	14.5-49.5cm	1219	a	0.009	0.121	14.6-44.4cm	749	a	0.004	0.23	14.5-49.5cm	470
	b	3.217	0.013			b	2.953	0.012			b	3.272	0.02		
2015	a	0.003	0.09	11.2-43.1cm	1310	a	0.003	0.113	18.5-43.1cm	928	a	0.005	0.123	11.2-42cm	382
	b	3.319	0.008			b	3.295	0.01			b	3.184	0.011		
2016	a	0.003	0.151	14.6-42.8cm	1148	a	0.002	0.17	17.4-42.8cm	710	a	0.009	0.207	14.6-40cm	438
	b	3.300	0.013			b	3.401	0.014			b	3.029	0.019		

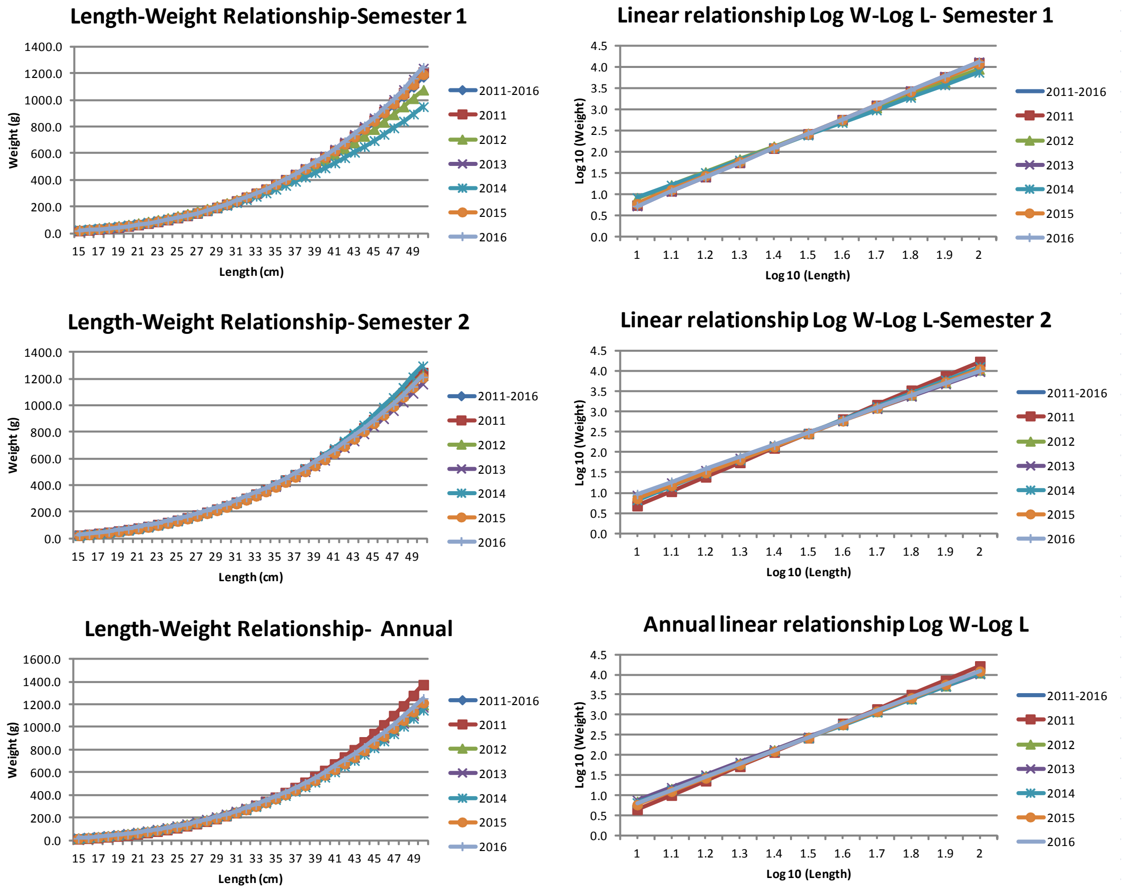


Figure 3.2.1.1. Length-weight relationships (panels on the left) and linear relationships (panels on the rigth) between logarithms of weight and length for chub mackerel sampled from the commercial fleet and surveys, 2011-2016.

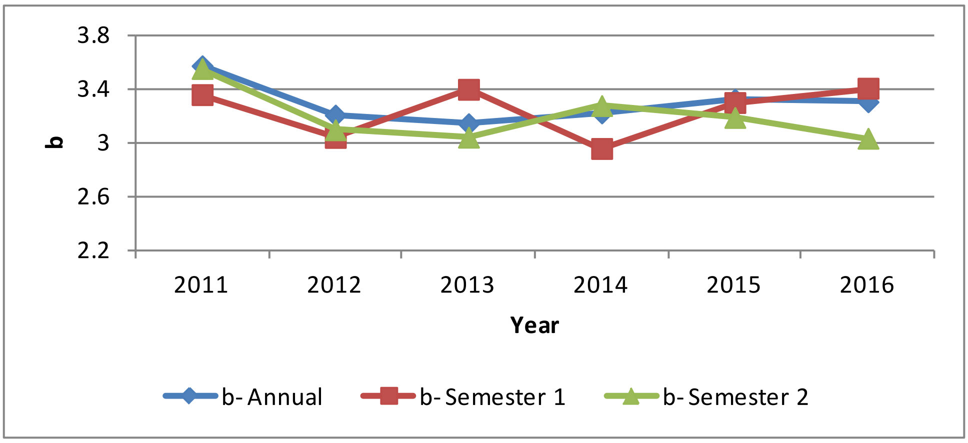


Figure 3.2.1.2. Variation of the values of regression coefficient (b) during 2011-2016.

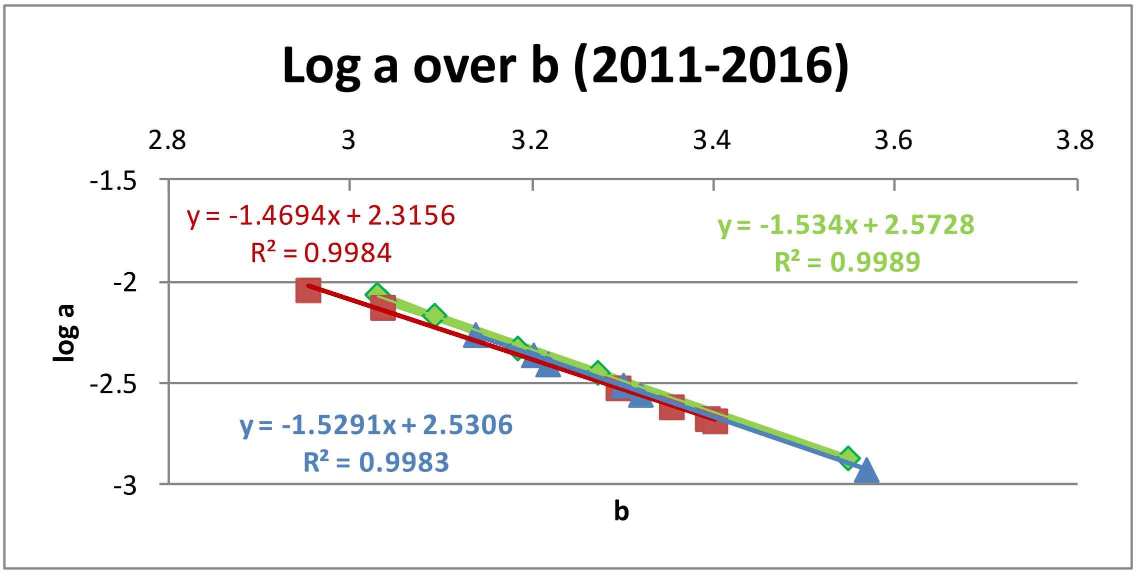


Figure 3.2.1.3. Plot of log a over b for 6 length-weight relationships of chub mackerel by half of year (first in red and second in green) and annual (in blue), 2011-2016.

3.2.2 Catch length composition (2011-2016)

Based on the length sampling of landings from the Spanish purse seine fleet, length frequency distributions (LFD) by quarter and ICES Division for the period 2011-2016 have been estimated. The statistical analysis of the mean size did not show significant differences among years (ANOVA: $F_{1,4}$= 0.816, p=0.418), although significant among quarters (ANOVA: $F_{1,2}$= 230.4, p<0.01) (Figure 3.2.2.1). Mean length per quarter is decreasing throughout the year, from 32 cm in winter to 28 cm in autumn.

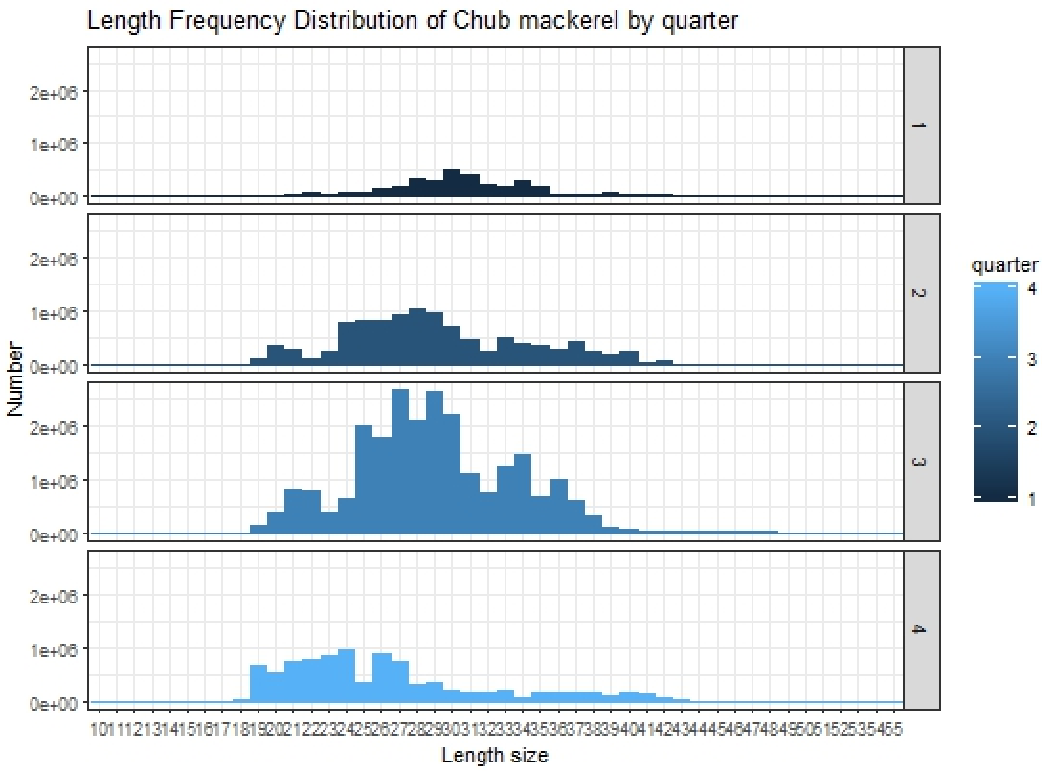


Figure 3.2.2.1. Length frequency distributions by quarter (average 2011-2016).

A Wilcoxon-Mann-Whitney test did not show significant differences inmean length between Division 8.c (33.2 cm) and Division 9.a (27.6 cm). However, the length frequency distributions show very different shape by ICES Division (Figure 3.2.2.2).

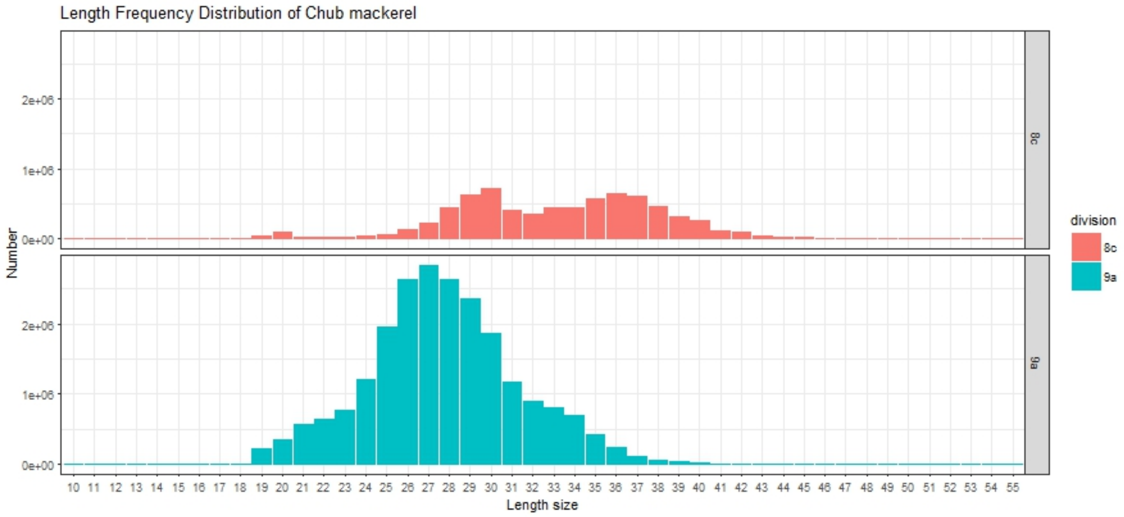


Figure 3.2.2.2. Length frequency distributions by ICES Division (average 2011-2016).

Yearly cumulated length distributions were also compared using Kolmogorov-Smirnov test. Year to year comparisons among cumulated length distributions by area with the average cumulated length distribution (2011-16 for 8c and 9aN and 2013-16 for 9aS). In 8c there seems to have been a decreasing trend in mean length from at around 37.8 cm, observed between 2011 and 2013, to 33.5 cm since 2014. No significant differences has been observed in length distribution inside each period (K-S statistics for all pair comparison for the first period is below 0.16 and below 0.06 for the second, figure 3.2.2.3a).

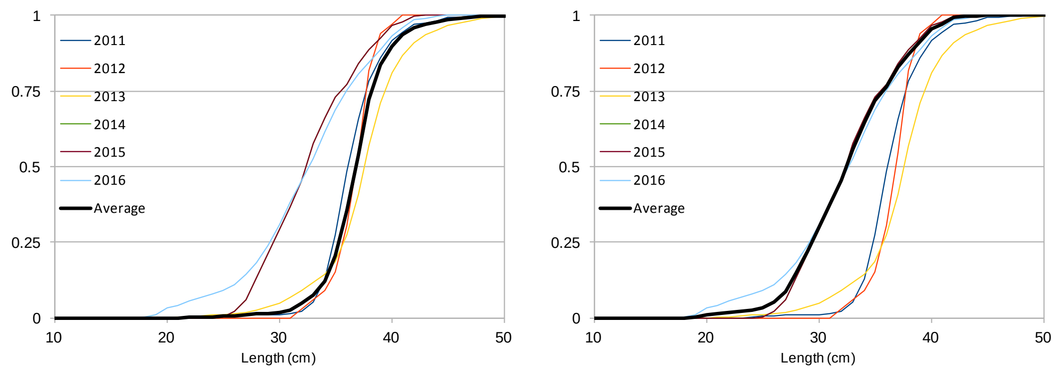


Figure 3.2.2.3a. Cumulated annual length distribution in 8c. Left panel showing in black the average cumulated distribution for the period 2011-13; and right panel, the average for the period 2014-16.

In 9aN, although the cumulated annual length distribution presented some variability along the time series, meaning different modes along the length distribution, no significant changes were observed (K-S statistics for all pair comparison was below 0.23, figure 3.2.2.3b), and mean length was almost stable at 30 cm.

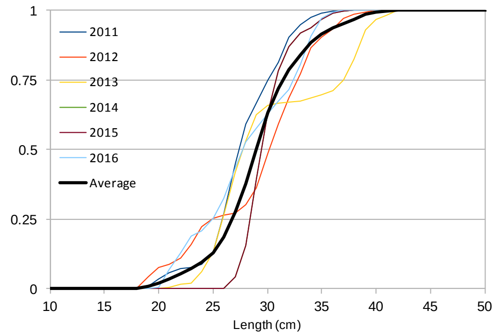


Figure 3.2.2.3b. Cumulated annual length distribution in 9aN together with the average cumulated distribution for the period 2011-16 (black line).

In 9aS data for 2011 and 2012 were not available. As in 9aN, no changes in length distribution were observed (K-S statistics for all pair comparison was below 0.20, figure 3.2.2.3c), but mean length was slightly different, at a 27.3.

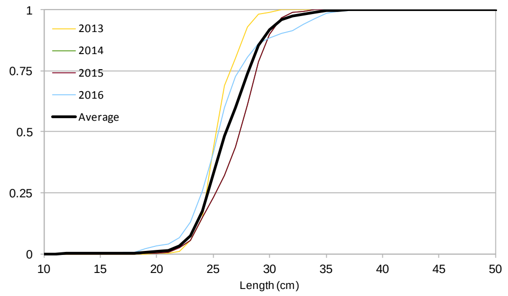


Figure 3.2.2.3c. Cumulated annual length distribution in 9aS together with the average cumulated distribution for the period 2011-16 (black line).

In overall, there is a length distribution gradient from 9aS, where the catches shows a length distributions with smaller fish, with a mean length of 27.4 cm to 8c where in spite the length distribution has changed in recent period, decreasing from 37.8 to 33.5, the bigger fish are located. Changes in length distribution are significant, with K-S statistics ranging from 0.32 to 0.58 (figure 3.2.2.3d).

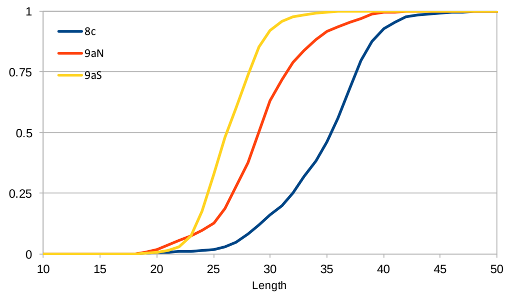


Figure 3.2.2.3d. Cumulated average length distribution (2011-16 for 8c and 9aN and 2013-16in for 9aS) for each area.

Mean length-at-age in the catch per quarter and area for 2011-2016 are shown in Table 3 of Annex 1. No trend in length has been observed in the analyzed period (Figure 3.2.2.4).

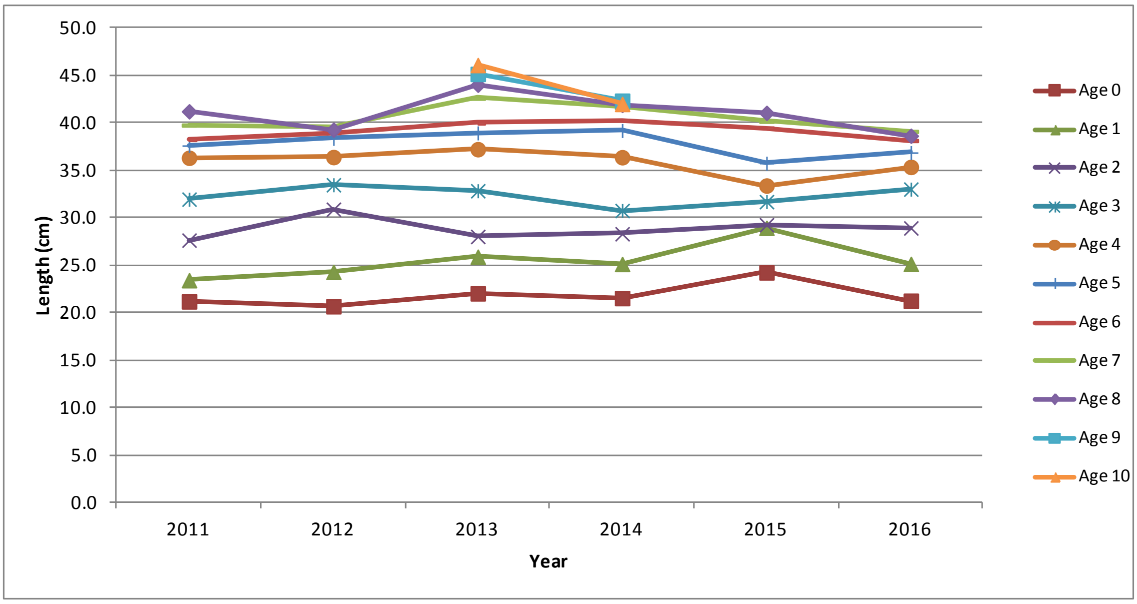


Figure 3.2.2.4. Chub mackerel mean length-at-age in the catch for the whole area, 2011-2016

3.2.3 Catch-at-Age (2011-2016)

Catch-at-age in number and in percentage by quarter and ICES Division for 2011-2016 are shown in Annex 1 (Tables 1 & 2) Over 70% of the catch belong to age groups 1-3 (Figure 3.2.3.1). Catches of young of the year (age group 0) are almost negligible and, when happen,take place in the second half of the year, mainly in Divisions 9.a.

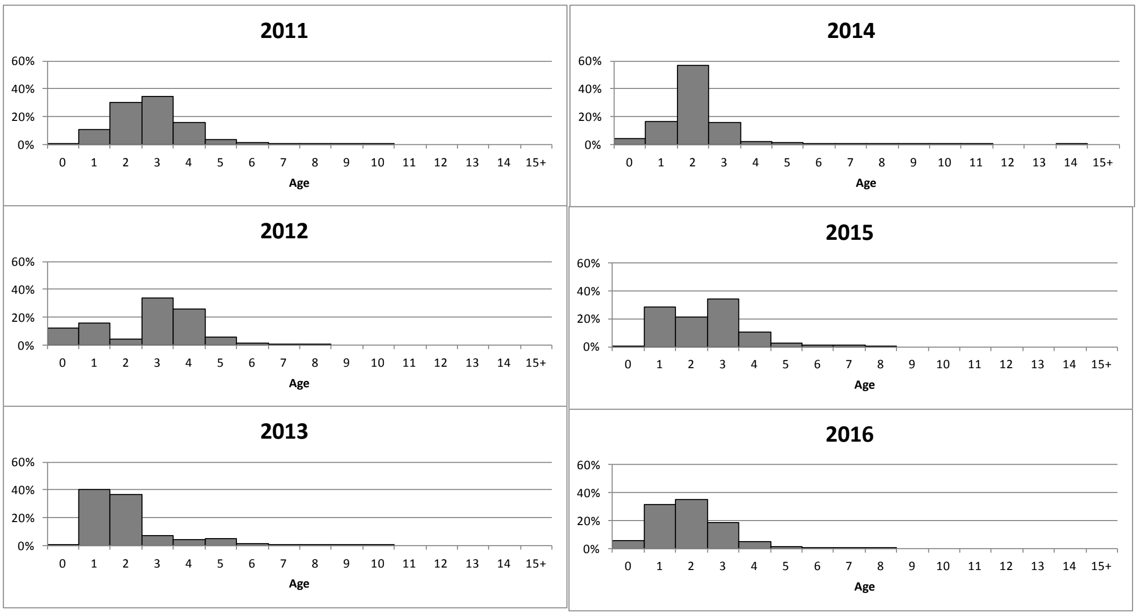


Figure 3.2.3.1. Catch- at-age (percentage) for whole area 2011-2016

Young fish (age groups 1 and 2) occur during the whole year throughout the area, although highly variable among years and areas. In Division 8.c young fish occur since 2014, and mainly in second half of the year.. Adult fish (Age group 2+) mainly occur in Division 8.c and most of the catches belong to f age groups 3-5. Age group 3 is also caught in t9.a Division, mainly in the northern area. Maximum recorded age was 14 The older fish are located in 8.c but in small proportion. (Figure 3.2.3.2).

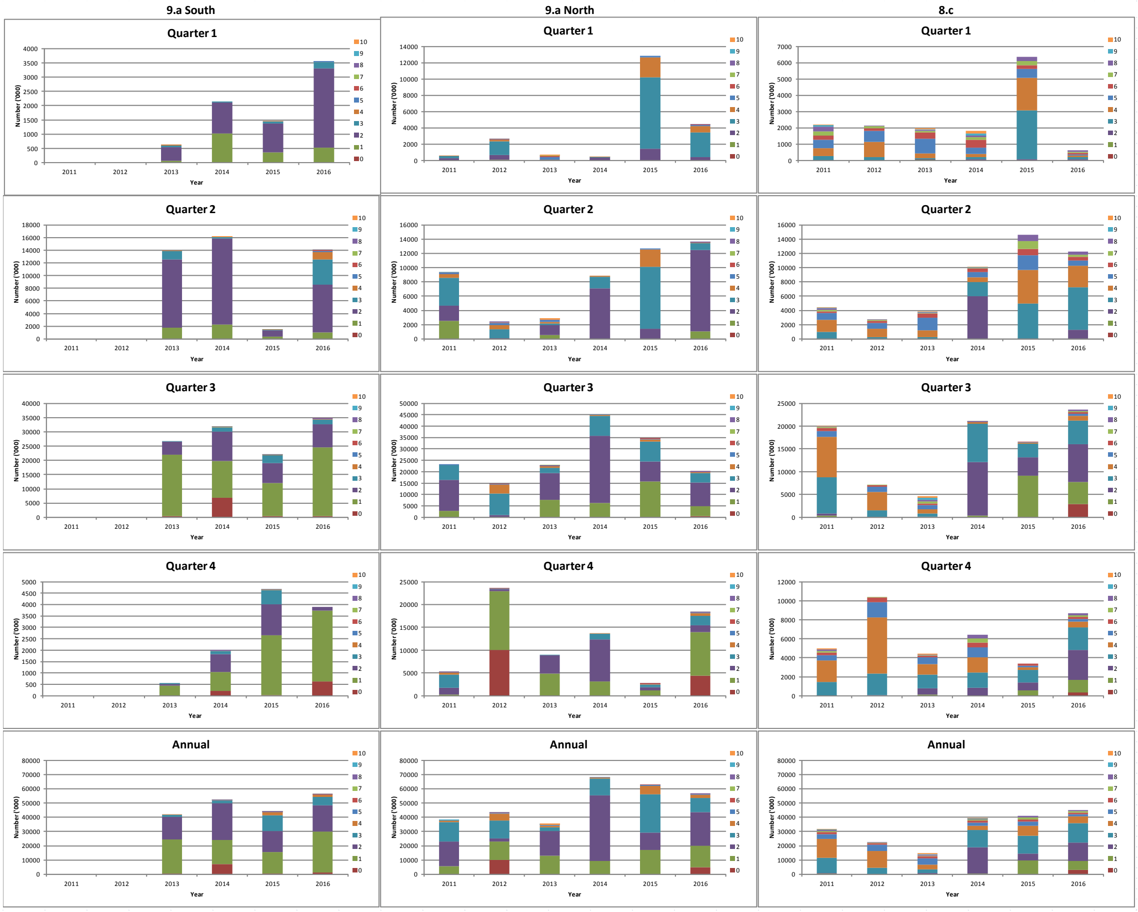


Figure 3.2.3.2. Age structure in catches by quarters and area (2011-2016)

3.2.4 Weights-at-Age in the Catch and Stock (2011-2016)

Mean weight-at-age in the catch per quarter and area for 2011-2016 is shown in Annex 1 (Table 4). As for length, no significant trend was observed (Figure 3.2.4.1). Table 3.2.4.1. shows the mean weight at age in the stock

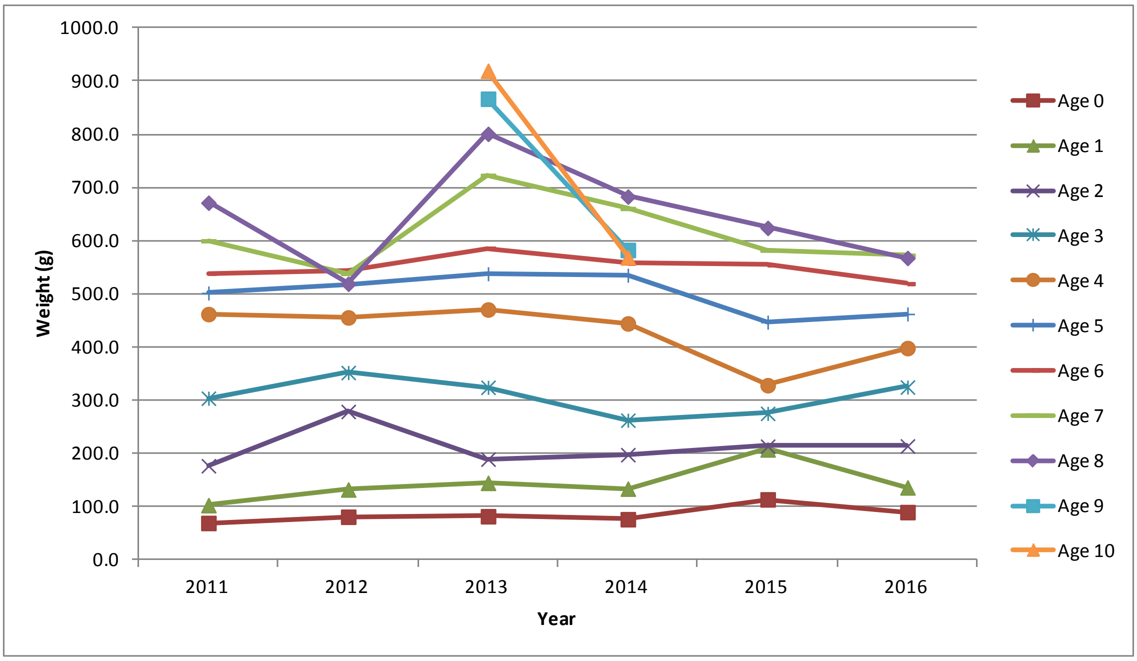


Figure 3.2.4.1. Chub mackerel. Mean weights-at-age in the catch for all area, 2011-2016

Table 3.2.4.1. Chub mackerel. Mean weight-at-age in the stock 2011-2016

Quarter 2	2011	2012	2013	2014	2015	2016
AGE	8.c	8.c	8.c	8.c	8.c	8.c
0						
1						
2	285	291	228	208	318	279
3	367	338	400	248	355	348
4	411	449	451	388	411	425
5	463	475	521	422	480	463
6	509	496	565	470	537	510
7	545	527	621	524	579	551
8	680	524	682	552	614	558
9	931		714	552		
10	973		810	538		
11				579		
12						
13						
14				629		
15+						
Mean (cm)	458	456	511	265	434	386

3.2.5 Maturity Ogive (2011-2016)

Higher percentages of active stages (i.e. in spawning activity) occurred from March to July (Figure 3.2.5.1). Peak spawning seems to occur earlier in Subdivision 9.a North than in 8.c on account the percentages of active stages in each area. Besides, in Division 8.c, although there seems to be active stages all year round, a clear peak is observed in June. Differences in life span and also in the peak of the spawning period between 9.a North and 8.c could be related with the different length and age structure in both areas, with the older fish located in 8.c which seems to be the main spawning area.

GSI analysis as well as the frequency of macroscopically active states of females analyzed between 2011 and 2016, reveals an increase of the spawning activity in March. GSI of females shows higher values from April to June with an apparent maximum in June. These results are in agreement with those observed in the monthly percentage of maturity stages (Figure 3.2.5.3).

Accordingly, the spawning period for chub mackerel in the Spanish waters seems to be between March and July.

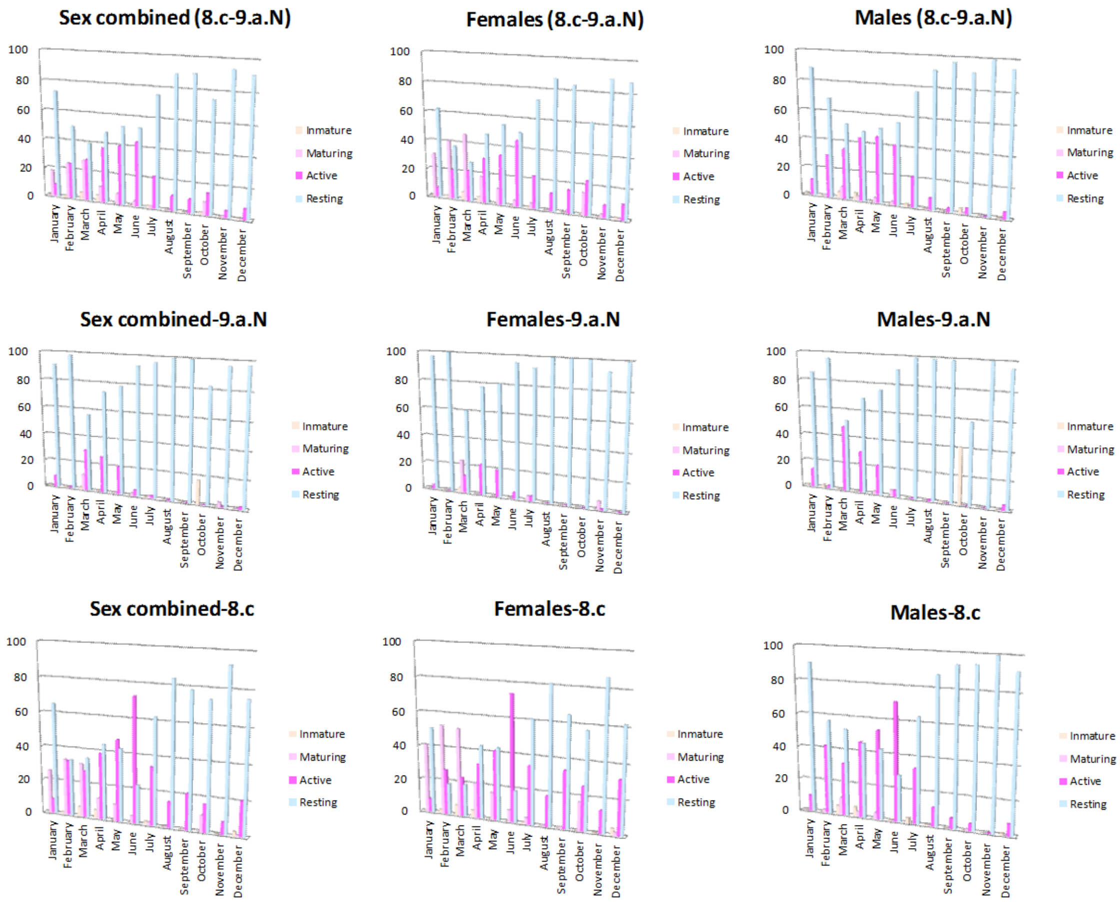


Figure 3.2.5.1. Monthly percentage of each maturity stage by sex and area 2011-2016

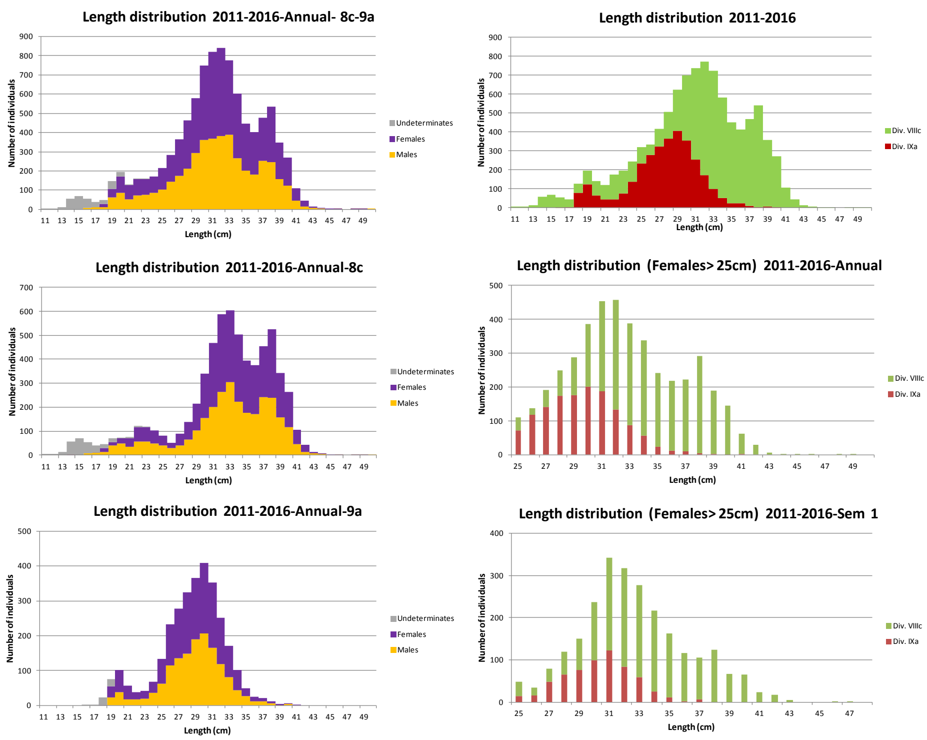


Figure 3.2.5.2 Length distribution of chub mackerel by sex and area 2011-2016

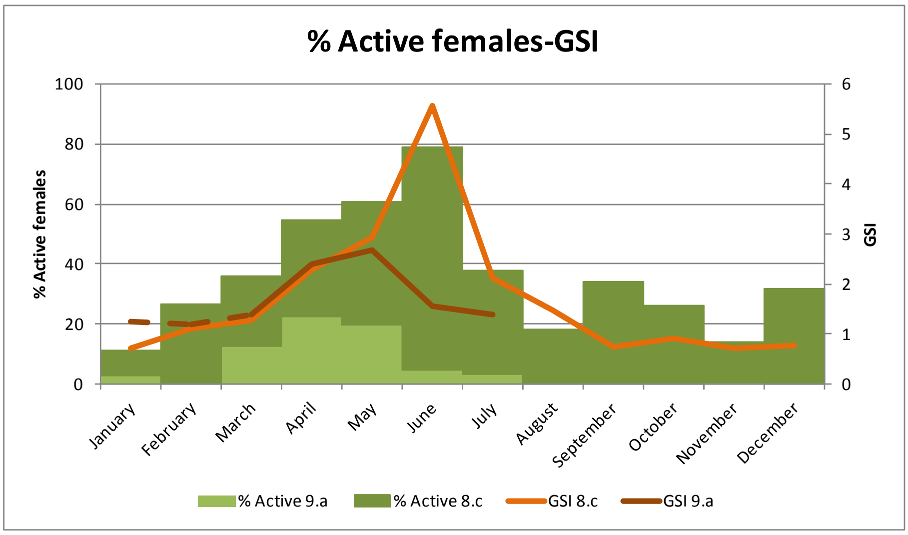


Figure 3.2.5.3 Monthly percentages and GSI of active females by area 2011-2016.

Tables 3.2.5.1 and 3.2.5.2 present the proportion of maturity at length and at age respectively, analyzed macroscopically. These data are presented by Sub-division and total. All logistic models converged, as shown in Table 3.2.5.4. Figure 3.2.5.4 and table 3.2.5.3 show the observed and modeled proportions of maturity at age.. First maturity was estimated to occur at 1.9 years old, corresponding to a mean length of 24.9 (Table 3.2.5.4).

Table 3.2.5.1. Maturity at length of chub mackerel females by areas and total during spawning season (April to July)

	9.a North			8.c			Total area		
LENGTH	Inm.	Mat.	% Mat.	Inm.	Mat.	% Mat.	Inm.	Mat.	% Mat.
14				1		0	1		0
15									
16									
17				1		0	1		0
18				16		0	16		0
19				13		0	13		0
20				22		0	22		0
21				29	5	15	29	5	15
22	3		0	51	10	16	54	10	16
23	1	7	88	48	11	19	49	18	27
24	1	5	83	43	8	16	44	13	23
25		13	100	30	7	19	30	20	40
26		21	100	7	10	59	7	31	82
27	2	52	96	4	29	88	6	81	93
28	1	64	98	1	56	98	2	120	98
29		76	100	1	60	98	1	136	99
30		75	100		103	100		178	100
31		95	100		165	100		260	100
32		78	100		203	100		281	100
33		60	100		207	100		267	100
34		37	100		186	100		223	100
35		14	100		143	100		157	100
36		3	100		91	100		94	100
37		7	100		66	100		73	100
38		1	100		84	100		85	100
39					51	100		51	100
40					52	100		52	100
41					16	100		16	100
42					15	100		15	100
43					4	100		4	100
44					1	100		1	100
45									
46					1	100		1	100
47									
48					1	100		1	100
TOTAL	8	608	99	267	1585	86	275	2193	89

Table 3.2.5.2. Maturity at age of chub mackerel females by areas and total during spawning season (April to July)

	9.a North			8.c			Total area		
AGE	Inm.	Mat.	% Mat.	Inm.	Mat.	% Mat.	Inm.	Mat.	% Mat.
1	2	13	87	173	48	22	175	61	26
2	5	93	95	86	265	75	91	358	80
3		176	100		501	100		677	100
4		52	100		190	100		242	100
5		9	100		106	100		115	100
6		2	100		24	100		26	100
7					18	100		18	100
8					15	100		15	100
9					1	100		1	100
10					3	100		3	100
11					1	100		1	100
12									
13									
14									
15+									
TOTAL	7	345	98	259	1172	82	266	1517	85

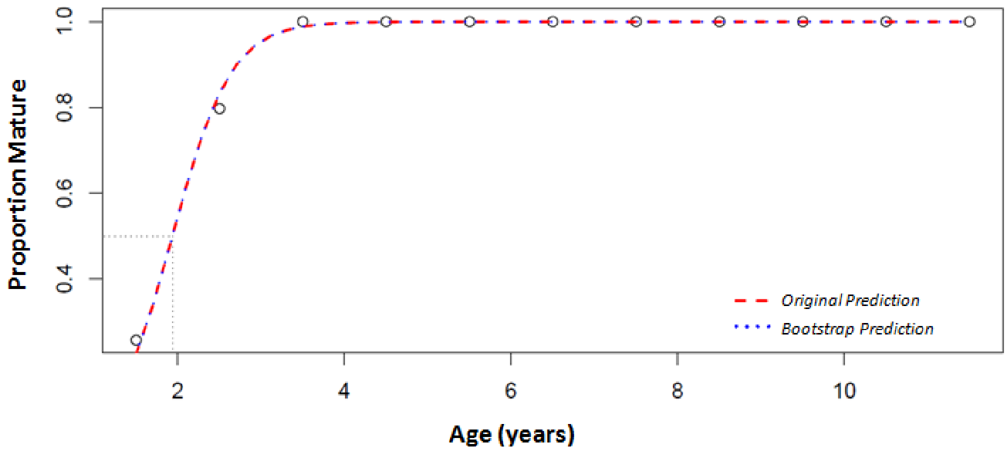


Figure 3.2.5.4. Chub Mackerel maturity ogives (females) after applying GLM model, 8c-9a North.

Table 3.2.5.3. Chub mackerel maturity ogives (females): proportion of maturity at age from original data and GLM model.

	Age 1	Age 2	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	Age 11
Original Data	0.258	0.797	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
GLM model	0.064	0.546	0.955	0.997	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 3.2.5.4. Parameter values B0 and B1 from the logistic model (GLM), mean age at first maturity (A50), mean length at first maturity (L50), coefficients of variation (CV) and the number of specimens sampled.

	B0	CV	B1	CV	A50	CV	n
Females	-5.534	0.061	2.8592	0.048	1.9335	0.02	1783

	B0	CV	B1	CV	L50	CV	n
Females	-23.5174	0.063	0.9407	0.059	24.9939	0.006	2468

3.3 Fishery Independent Data

3.3.1 Acoustic-trawl Surveys

3.3.1.1 PELACUS surveys (9.a North and 8.c areas): Spring 2013-2016

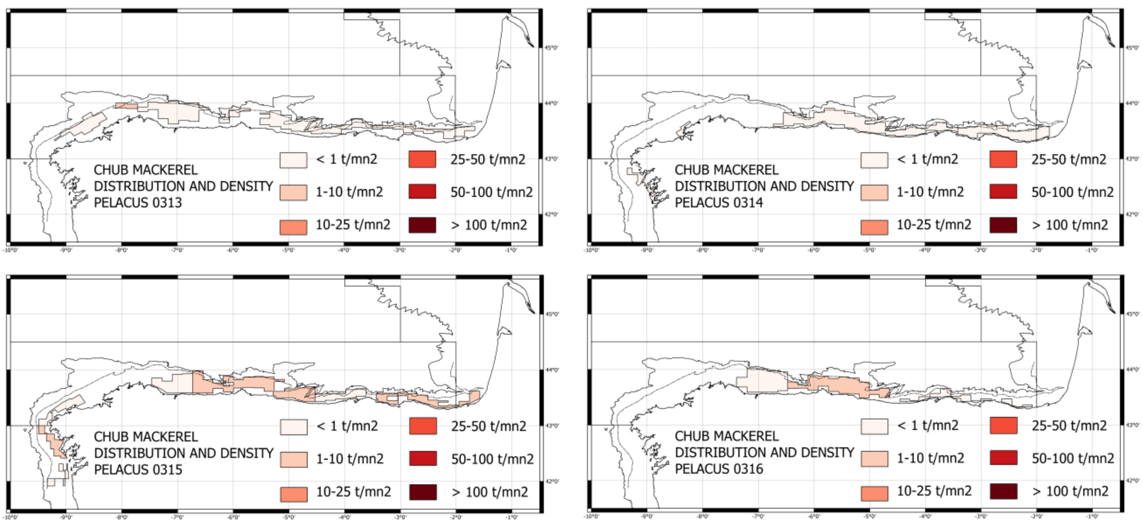
Table 3.3.1.1.1 summarizes main findings on fishing stations. In general, chub mackerel presence in the fishing stations is scarce, although has increased in the most recent years. The % of fishing station in which more than 30 individuals were caught increased from a 9% in 2013 to a 20.7% in 2017. This is important since when no direct allocation accounting the echotrace features is possible, fishing stations, as a ground-truthing proxy for fish species proportion to split backscattering energy, are used.

Table 3.3.1.1.1. Summary of results for chub mackerel on fishing stations in PELACUS. (*Total Fst* is the total trawl haul done in each survey; *Catch (kg)* and *No fish* is the total catch of chub mackerel both in weight and in number: *Presence* is the number of fishing station with at least one individual of chub mackerel; *Id>30 ind*, is the number of fishing stations with 30 or more invididuals, both also expressed in %: and *Mean length* is the length weighting average (total catch in number per tow as a weighting factor). Note that for 2017, only data from the Spanish area are included).

	Total Fst	Catch (Kg)	No fish	Presence	Id >30 ind	%Pres.	%Pres. >30 Indiv.	Mean length
2013	44	92	964	24	4	54.55	9.09	23.46
2014	52	249	1004	23	4	44.23	7.69	31.40
2015	66	489	1949	24	10	36.36	15.15	30.14
2016	44	218	2392	13	7	29.55	15.91	24.29
2017*	58	1377	22763	27	12	46.55	20.69	23.75

Abundance and biomass estimates are also low in comparison to other fish species. In comparison to those of mackerel, chub mackerel biomass only represents the 0.81% on average (range 0.05-1.88) and 2.86% (range 0.08-7.97) in number.

Figure 3.3.1.1.1 shows the density spatial distribution along the time series. As expected, abundance is very low, almost below 1 ton per square nautical mile. Nevertheless in 2017, a significant increase in biomass was detected in 9a.



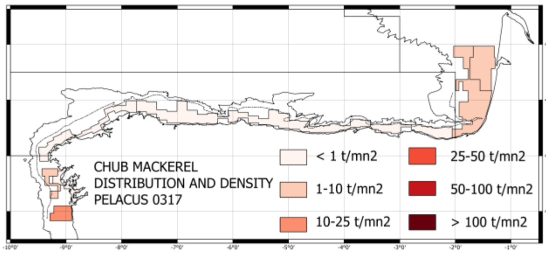


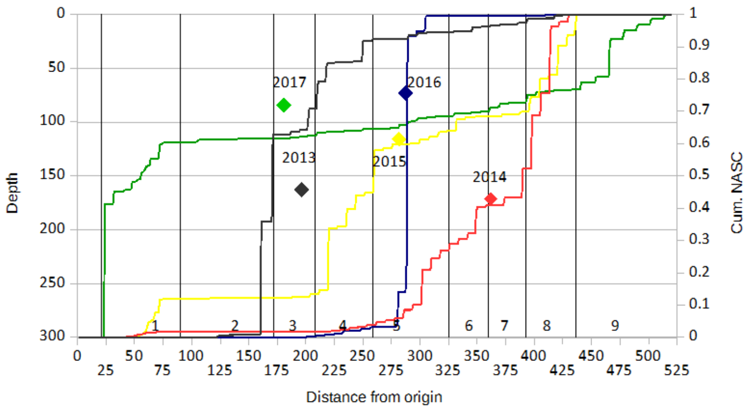
Figure 3.3.1.1.1. Cub mackerel spatial distribution density

This year the survey was extended towards French waters, covering south 8b (until 45ºN). In this area, chub mackerel density was also important and most of the fish, as observed in 9a, the bulk of the population belonged to age group 1 (82% in number in 8b, 72% in 9a; in 8c although also important, comprises only 57% -56%, 57% and 36% respectively in weight).

Cumulated relative S_A together with the weighted average of both depth and distance from the origin can be used as well as a proxy of the chub mackerel distribution. Table 3.3.1.1.2 shows the obtained results. Mean depth is decreasing along time series as well as the distance to the 200 m isobath increases, although cv is also increasing meaning that the distribution is shifting towards shallower waters but still occupying deeper waters. The center of gravity of the distribution is still located in the Cantabrian Sea.

Table 3.3.1.1.1. Total backscattering energy attributed to chub mackerel (NASC, s_A) per year with the weighted average of depth, distance to the 200 isobath and distance from the origin (expressed in nautical miles, located in the Spanish Portuguese border) using the NASC value at each nautical mile as weighting factor together with the standard deviation and the confidence interval.

	2013	2014	2015	2016	2017
Total NASC	1546	832	3835	13665	10429
Depth	162.75	171.19	116.00	73.02	84.42
s.d.	31.99	44.96	55.36	21.36	54.51
ic	3.82	5.38	6.60	2.55	6.50
Dist 200	4.03	4.40	5.01	7.58	9.13
s.d.	1.80	1.55	3.50	4.85	9.97
ic	0.21	0.19	0.42	0.58	1.19
Dist	196.03	361.81	281.67	287.44	180.62
s.d.	33.01	28.23	106.61	25.94	298.87
ic	3.94	3.38	12.72	3.09	35.65



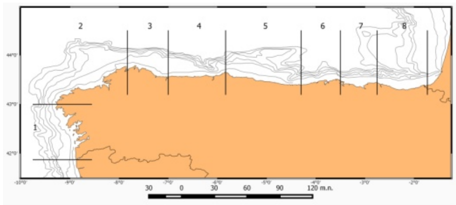


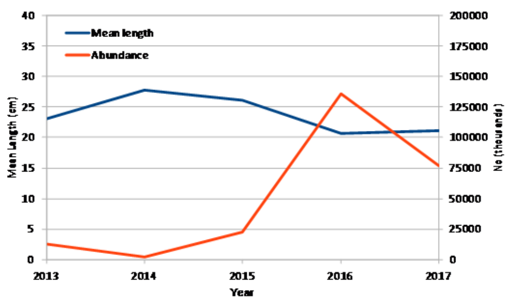
Figure 3.3.1.1.2: Cumulated chub mackerel NASC distribution by year along the surveyed area and the center of the distribution in relation to weighted average of depth and distance from the origin. (black line and dot, 2013; red, 2014; yellow, 2015; blue, 2016; and green 2017). The map shows the areas related to the numbers put down on the plot.

Figure 3.3.1.1.2 shows the cumulated NASC from the origin of the survey track, located in the Spanish Portuguese border. In years 2013, 2015 and 2016 the distribution was mainly concentrated in the central part of the Cantabrian Sea, although in 9a around 12% of the cumulated distribution was observed. In 2014, the distribution shifted towards the inner part of the Bay of Biscay. This predominance of 8c changed significantly in 2017 when the bulk of the distribution was located in 9a (up to 60% of the cumulated values; excluding those observed in 8b, this percentage could reach up to 75%). Only age groups 1 and 2 were found in this area, probably arriving from Portugal. It should be also highlighted the absence of this specie in the western corner of the Iberian Peninsulas where, at least in sprint times seems to most unsuitable habitat for this specie.

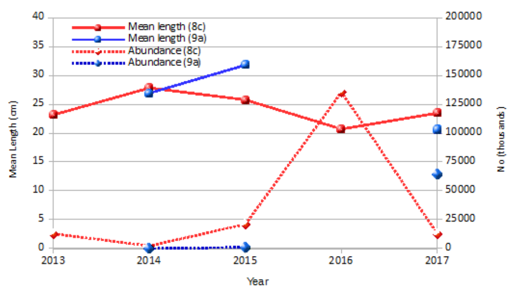
A series of population descriptors are shown in figure 3.3.1.1.3. Abundance estimates shows a clear increasing trend, which is much clearer than that observed in mean length (figure 3.3.1.1.3 a). This trend is observed in both 8a and 9a, although in 2017 the abundance was lower than that estimated in 2016 (figure 3.3.1.1.3 b). As can be also observed, some years (2013 and 2016) no estimation was made in 9a as the amount of backscattering energy together with the lack of a comprehensive length distribution led this specie be below of the minimum threshold for an acceptable assessment. Similar evolution is observed in both biomass estimates and mean weight (figures 3.3.1.1.3c-d).

Mean length at age and mean weight at age, although showing a great variability, have no significant trends along the time series. Nevertheless as observed as well for mackerel, younger ages (1-3) use to show a greater relative variability as compared with the older (figures 3.3.1.1.3 e-h).

a)



b)



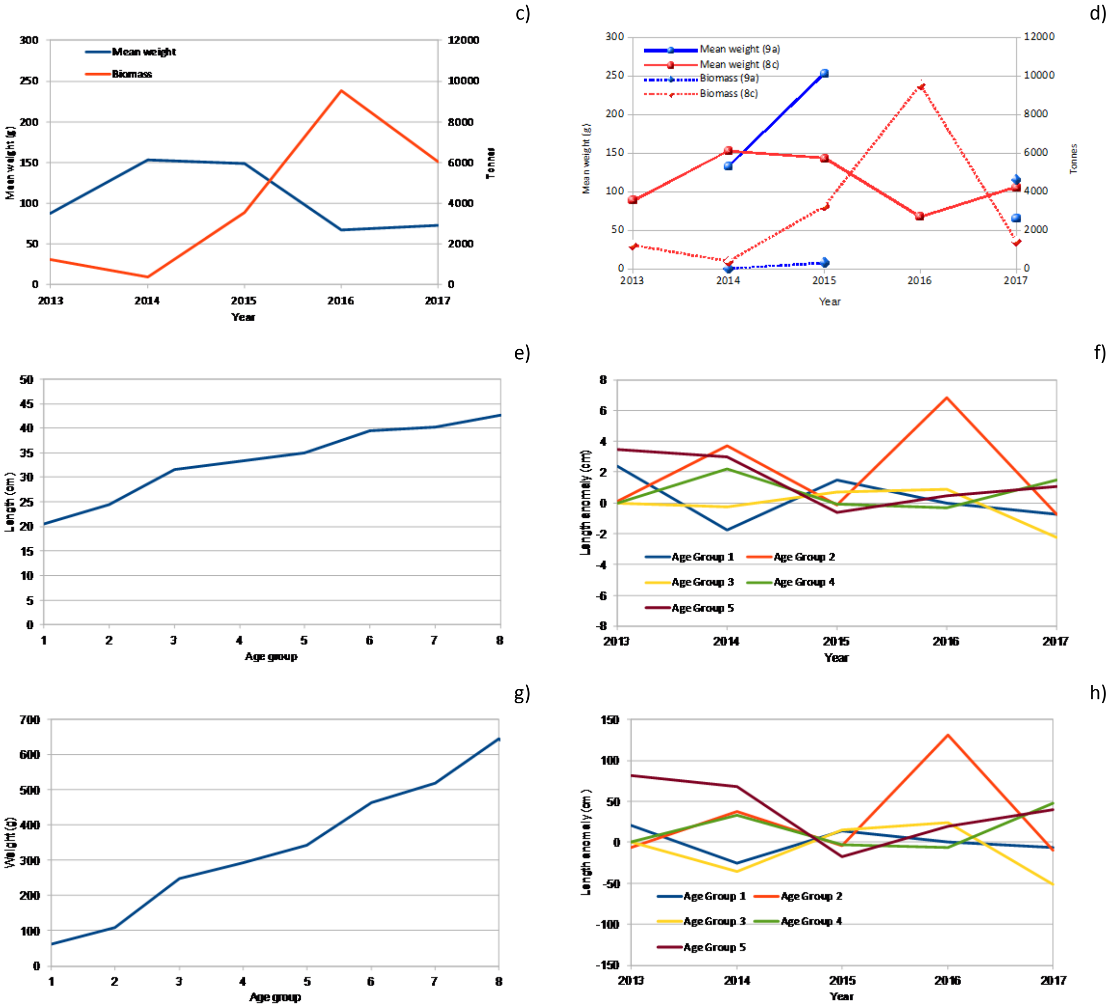


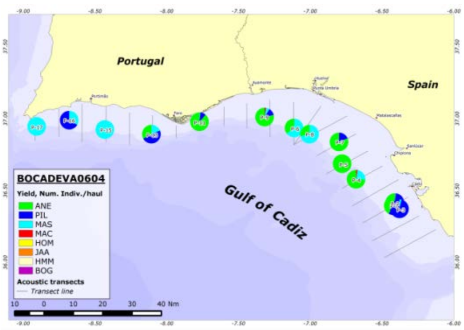
Figure 3.3.1.1.3: Chub mackerel population indicators from PELACUS (2013-17); a) abundance estimates (thousand fish) and mean length estimated in each survey; b) id split by division (8c and 9a); c) biomass and mean weight for the whole area; d) id for each division; e) mean length at age (average mean length for the whole times series); f) length at age anomalies for each year (difference between overall mean length at age and the mean length at age for a specific year); g) mean weight at age; and f) weight at age anomalies

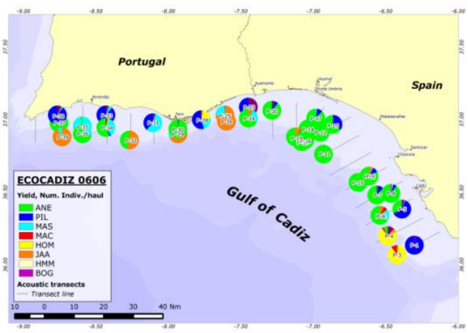
3.3.1.2 ECOCADIZ surveys (9.a South): Summer 2004-2016

The number of valid ground-truthing pelagic hauls per survey has oscillated between 13 and 34 hauls (Table 3.3.1.2.1, Figure 3.3.1.2.1). The species assemblage is mainly characterized by anchovy (*Engraulis encrasicolus*), sardine (*Sardina pilchardus*) and chub mackerel (*Scomber colias*) as dominant, widely distributed and highly persistent species, together with Atlantic mackerel (*S. scombrus*), horse mackerel (*Trachurus trachurus*), blue jack mackerel (*T. picturatus*) and bogue (*Bogue bogue*). Mediterranean horse mackerel (*T. mediterraneus*) is also relatively frequent, although only distributed over the easternmost waters, close to the Strait of Gibraltar. The occurrence of blue whiting (*Micromesistius poutassou*) and boarfish (*Capros aper*) in the surveyed area is rather occasional since the acoustic sampling is restricted to the shelf waters (≤200 m depth).

Table 3.3.1.2.1. *ECOCADIZ* survey series. Percentages of occurrence in valid fishing hauls of the most frequent pelagic fish species (ANE: *E. encrasicolus*; BOC: *C. aper*; BOG: *B. boops*; HOM: *T. trachurus*; HMM: *T. mediterraneus*; JAA: T. *picturatus*; MAC: *S. scombrus*; MAS: *S. colias*; PIL: *S. pilchardus*; WHB: *M. poutassou*). Note that the 2010 survey only covered the shelf between Cape Trafalgar – Cape Santa Maria.

Survey	Year	# valid hauls	MAS	ANE	PIL	MAC	HOM	HMM	JAA	BOG	WHB	BOC
BOCADEVA 0604	2004	13	**92.3**	76.9	61.5	76.9	7.7	7.7	7.7	38.5	0.0	7.7
ECOCADIZ 0606	2006	34	**79.4**	67.7	82.4	52.9	38.2	14.7	61.8	70.6	0.0	0.0
ECOCADIZ 0707	2007	32	**93.6**	61.3	54.8	67.7	29.0	58.1	38.7	67.7	0.0	0.0
ECOCADIZ 0609	2009	28	**82.1**	82.1	53.6	57.1	60.7	28.6	75.0	53.6	0.0	0.0
ECOCADIZ 0710	2010	17	**76.5**	88.2	76.5	64.7	58.8	29.4	58.8	64.7	0.0	0.0
ECOCADIZ 0813	2013	16	**81.3**	75.0	56.3	68.8	75.0	37.5	81.3	62.5	0.0	0.0
ECOCADIZ 2014-07	2014	20	**76.2**	90.5	52.4	81.0	90.5	23.8	90.5	57.1	15.0	10.0
ECOCADIZ 2015-07	2015	19	**78.9**	78.9	94.7	73.7	84.2	21.1	52.6	57.9	15.8	10.5
ECOCADIZ 2016-07	2016	26	**100.0**	84.6	57.7	84.6	65.4	26.9	46.2	61.5	11.5	7.7





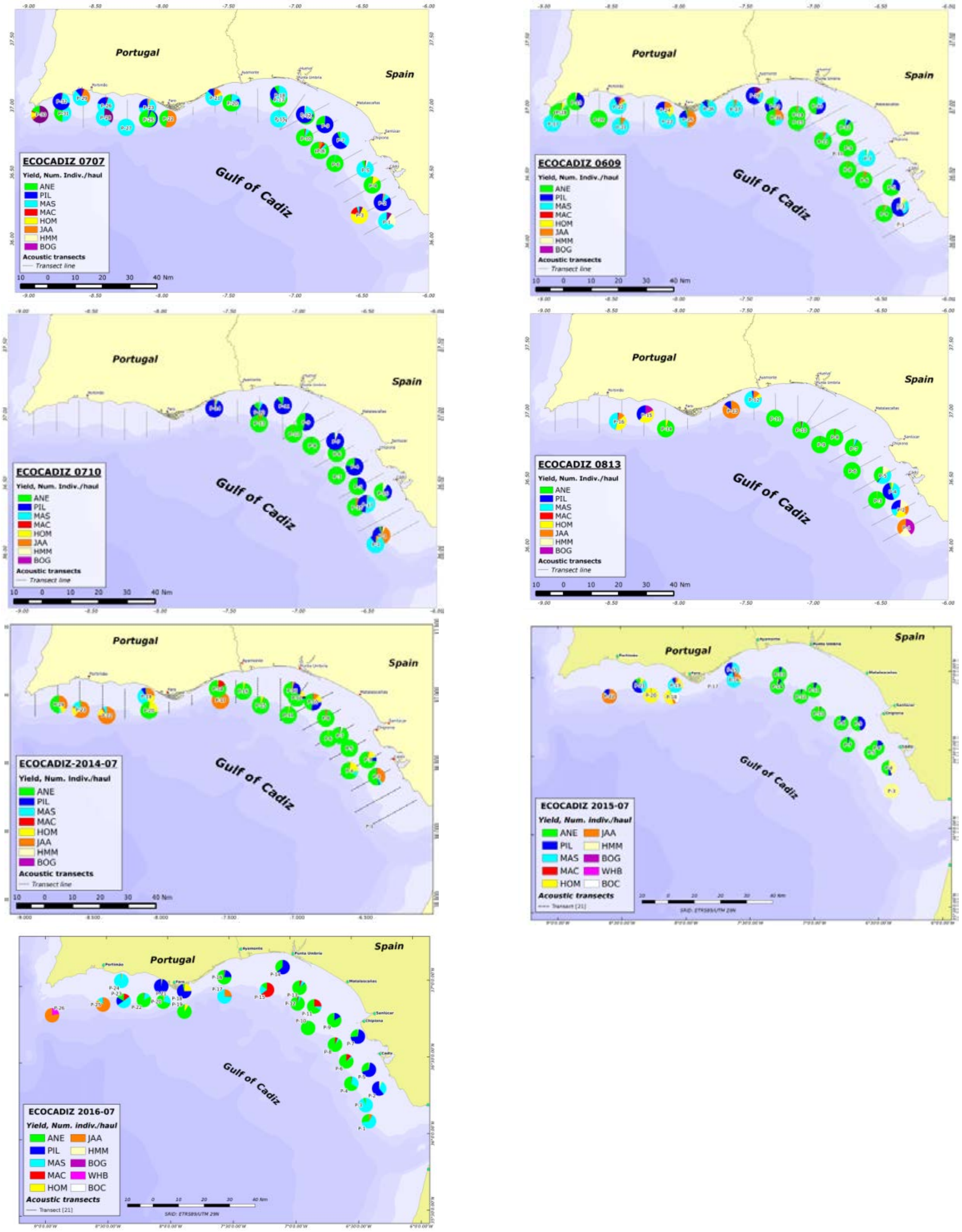
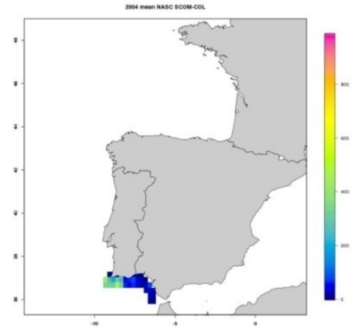
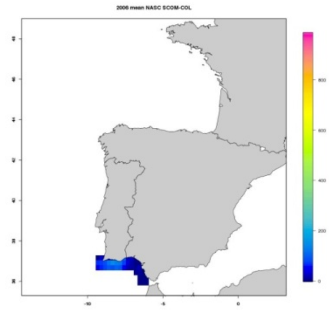
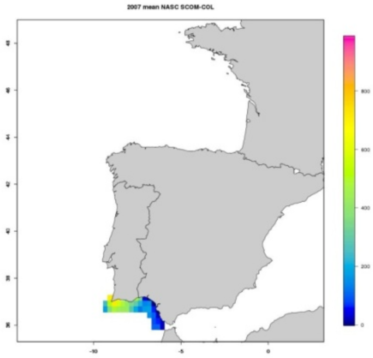


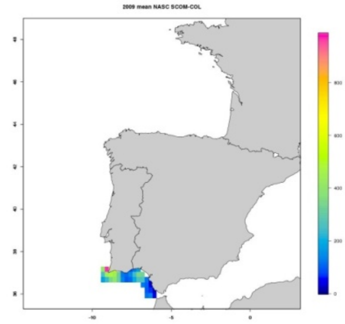
Figure 3.3.1.2.1. *ECOCADIZ* survey series. Species composition (% in numbers) in valid pelagic hauls. Note that the 2010 survey only covered the shelf between Cape Trafalgar – Cape Santa Maria.

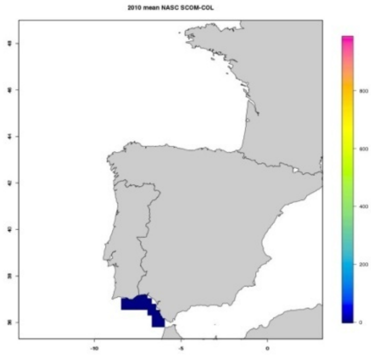
Chub mackerel, although widely distributed over the whole surveyed area, seems to show some preference for the westernmost mid- and outer shelf waters (Portuguese area) of the Gulf, with a secondary nucleus of occurrence in the easternmost extreme of the surveyed area occurring in some years.

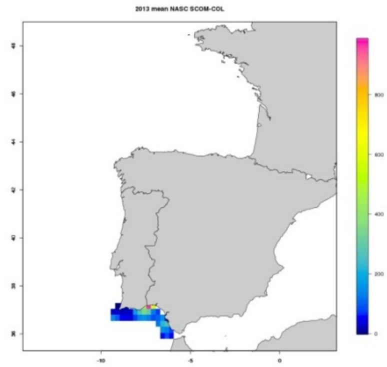

2004 mean NASC SCOM-COL

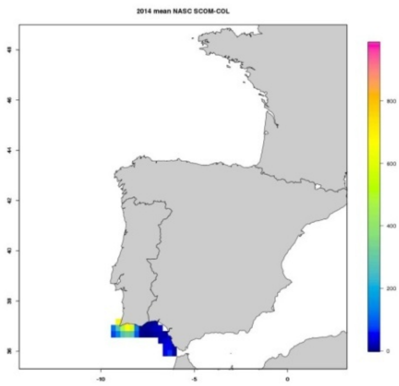

2006 mean NASC SCOM-COL

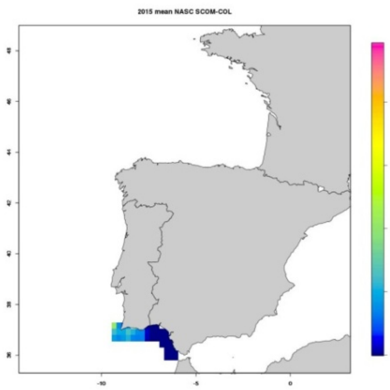

2007 mean NASC SCOM-COL


2009 mean NASC SCOM-COL


2010 mean NASC SCOM-COL


2013 mean NASC SCOM-COL


2014 mean NASC SCOM-COL


2015 mean NASC SCOM-COL

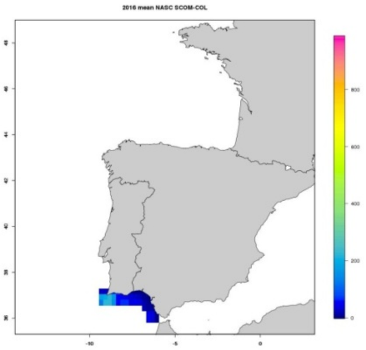
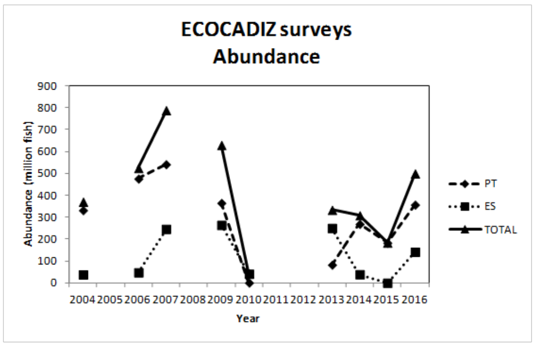


Figure 3.3.1.2.2. *ECOCADIZ* survey series. *S. colias*. Grid maps showing the spatial distribution of the backscattering energy (nautical area scattering coefficient, NASC, in m^2 nmi^{-2}) attributed to chub mackerel. Note that the 2010 survey only covered the shelf between Cape Trafalgar – Cape Santa Maria.

Table 3.3.1.2.2 and Figure 3.3.1.2.3 show the overall and regional (i.e., Portuguese and Spanish) acoustic estimates of chub mackerel abundance and biomass in each of the ECOCADIZ surveys. The bulk of the estimated population is usually recorded (but in 2013) in the Portuguese waters. During the available series (excepting the 2010 partial estimate), the population levels have oscillated between 184 and 788 million fish, corresponding to 21593 and 61530 t, respectively, occurred in 2015 and 2007, respectively. (). Time series shows two periods with different trend in the stock size indicator: a first period of relatively high population levels between 2006 and 2009, and a most recent period (2010-2015) characterized by a decreasing trend, about half of the previous records. Some population increase was recorded again in 2016.

Table 3.3.1.2.2. *ECOCADIZ* survey series. *S. colias*. Acoustic estimates of abundance (in million fish) and biomass (in tones) by country and the whole surveyed area (Sub-division 9a South). Note that the 2010 survey only covered the shelf between Cape Trafalgar – Cape Santa Maria and, therefore, the estimate for Portuguese waters is only a partial one.

Year	ABUNDANCE (millions)			BIOMASS (t)		
	PT	ES	TOTAL	PT	ES	TOTAL
2004	332	39	371	30077	3181	33258
2005						
2006	476	48	524	29995	5585	35580
2007	542	247	788	39206	22324	61530
2008						
2009	365	264	629	28935	27341	56276
2010	1	42	43	2750	111	2861
2011						
2012						
2013	83	250	333	6993	24274	31267
2014	269	39	308	19029	3228	22258
2015	183	0,6	184	21474	119	21593
2016	357	142	499	19762	5156	24918



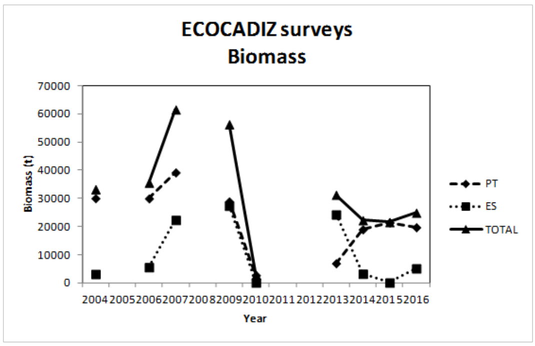
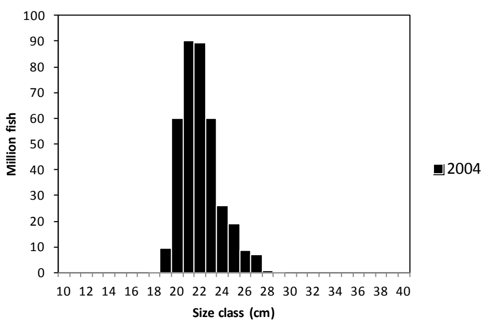
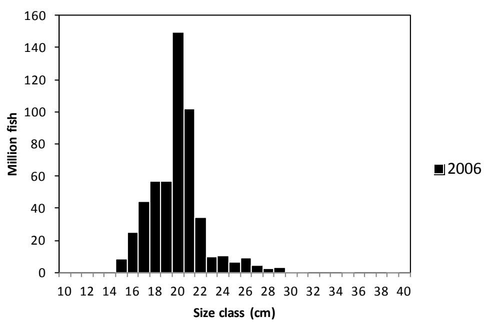


Figure 3.3.1.2.3. *ECOCADIZ* survey series. *S. colias*. Acoustic estimates of abundance (in million fish) and biomass (in tones) by country and the whole surveyed area (Sub-division 9a South). Note that the 2010 survey only covered the shelf between Cape Trafalgar – Cape Santa Maria and, therefore, the estimate for Portuguese waters is only a partial one.

The overall size range of chub mackerel in summer oscillated between 10 and 39 cm (Figure 3.3.1.2.4). The size composition of the estimated population showed a certain degree of mixing in some years. The modal size class is usually located at around the 19, 20, 21 or 22 cm size classes, whenever the size composition is not a composite one. In those years with a clear composite size composition (2010, 2014, 2015), two modes are identified, a smaller one at 18-19 cm and a larger mode at 24 cm, although the importance of each of these components in the population differs depending on the year. The species size composition in 2016 deserves special mention since the population is mainly composed by the smallest fish ever recorded, at around the 15 cm modal size class, and with a secondary mode at 26 cm.

The population age structure corroborates the patterns observed in the size data, evidencing a population mainly composed by juvenile and young (age 0 and 1 fish), with the age 0 fish usually accounting for more than 75% of the whole population (Figure 3.3.1.2.5). The occurrence of fish older than 3 years old seems to be incidental in summer. The high relative importance of very small age-0 fish in the 2016 population translated into a decrease of the overall mean size and weight in the population (Figure 3.4.1.2.6).





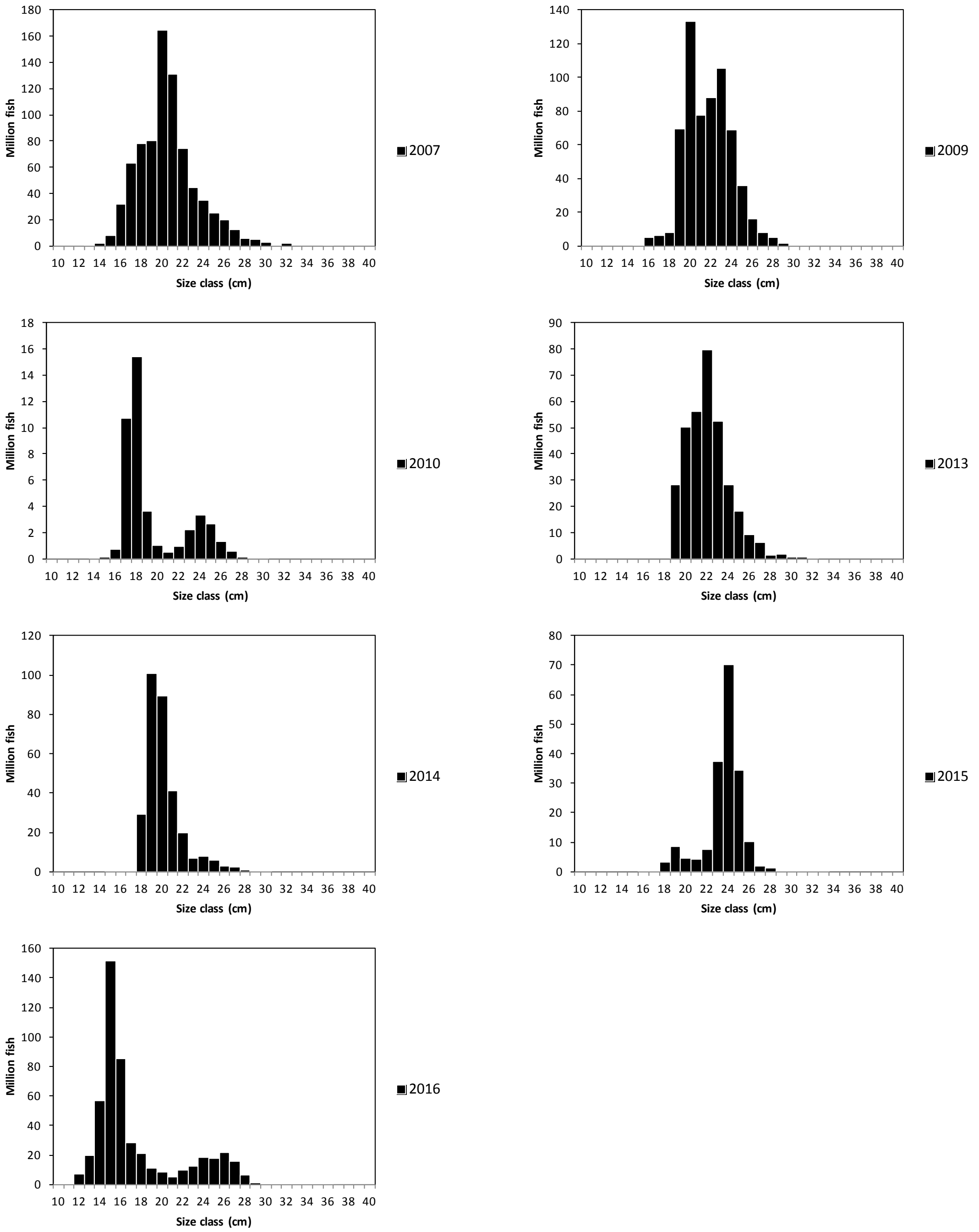


Figure 3.3.1.2.4. *ECOCADIZ* survey series. *S. colias*. Acoustic estimates of abundance (in million fish) by size class (in cm) for the whole surveyed area (Sub-division 9a South). Note that the 2010 survey only covered the shelf between Cape Trafalgar – Cape Santa Maria and, therefore, the estimate for Portuguese waters is only a partial one. Also note the different scale of the *y* axis.

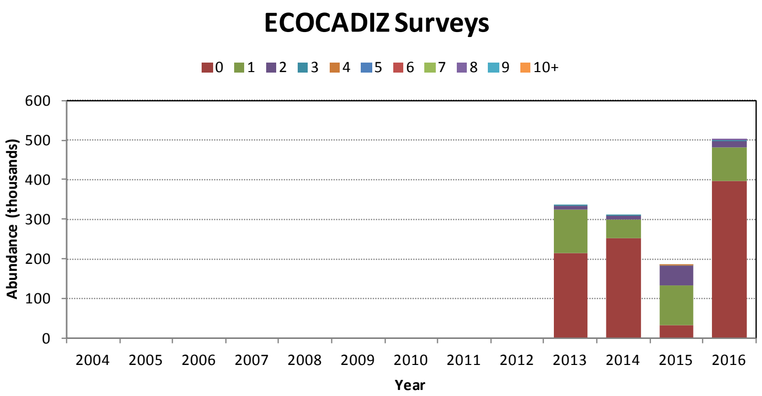


Figure 3.3.1.2.5. *ECOCADIZ* survey series. *S. colias*. Acoustic estimates of abundance (in million fish) by age group for the whole surveyed area (Sub-division 9a South). Age structure estimated by applying the available ALKs for the second semester from pooled commercial and surveys samples from the Sub-divisions 8c and 9a N.

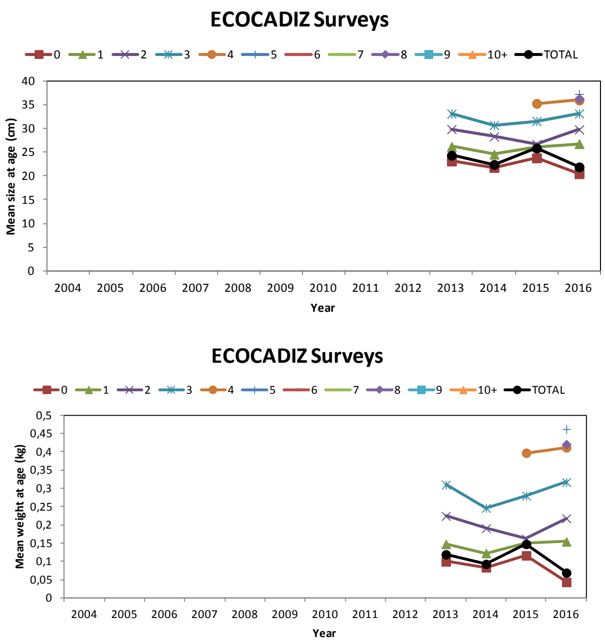


Figure 3.3.1.2.6. *ECOCADIZ* survey series. *S. colias*. Mean size (in cm, upper panel) and mean weight (in k, lower panel) by age group for the whole surveyed area (Sub-division 9a South). Age structure estimated by applying the available ALKs for the second semester from pooled commercial and surveys samples from the Sub-divisions 8c and 9a N.

3.3.1.3 ECOCADIZ-RECLUTAS surveys (9.a South): Autumn 2012-2016

The Gulf of Cadiz pelagic fish assemblage in autumn resembles pretty much to the one described in summer, with the trio of anchovy, sardine and chub mackerel being the more frequent and dominant species. This species set is also accompanied by the Atlantic mackerel, horse mackerel, Mediterranean horse mackerel and blue jack mackerel and bogue (Table 3.3.1.3.1, Figure 3.3.1.3.1).

Table 3.3.1.3.1. *ECOCADIZ-RECLUTAS* survey series. Percentages of occurrence in valid fishing hauls of the most frequent pelagic fish species (ANE: *E. encrasicolus*; BOC: *C. aper*; BOG: *B. boops*; HOM: *T. trachurus*; HMM: *T. mediterraneus*; JAA: T. *picturatus*; MAC: *S. scombrus*; MAS: *S. colias*; PIL: *S. pilchardus*; WHB: *M. poutassou*). Note that the 2012 survey only covered the Spanish waters.

Survey	Year	# valid hauls	MAS	ANE	PIL	MAC	HOM	HMM	JAA	BOG	WHB	BOC
ECOCADIZ-RECLUTAS 1112	2012	10	**100.0**	100.0	80.0	70.0	100.0	80.0	70.0	50.0	0.0	0.0
ECOCADIZ-RECLUTAS 2014-10	2014	15	**86.7**	60.0	40.0	53.3	33.3	53.3	26.7	20.0	0.0	0.0
ECOCADIZ-RECLUTAS 2015-10	2015	21	**66.7**	95.2	71.4	57.1	61.9	23.8	38.1	33.3	14.3	4.8
ECOCADIZ-RECLUTAS 2016-10	2016	16	**75.0**	75.0	87.5	56.3	43.8	37.5	31.3	31.3	0.0	6.3

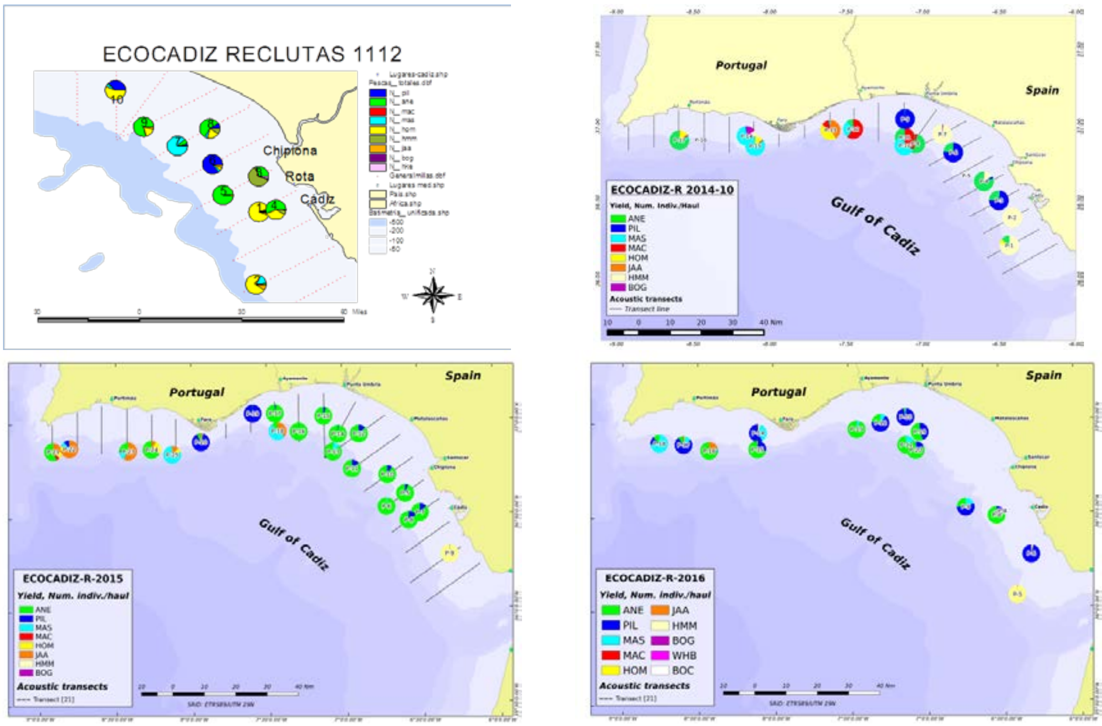


Figure 3.3.1.3.1. *ECOCADIZ-RECLUTAS* survey series. Species composition (% in numbers) in valid pelagic hauls. Note that the 2012 survey only covered the Spanish waters.

Regarding the spatial distribution of the species in autumn, chub mackerel is distributed in quite similar way to the one described for the summer survey series: a wide distribution over the whole surveyed area, but showing a marked preference for the westernmost mid- and outer shelf waters of the Gulf (Figures 3.3.1.3.1 and 3.3.1.3.2).

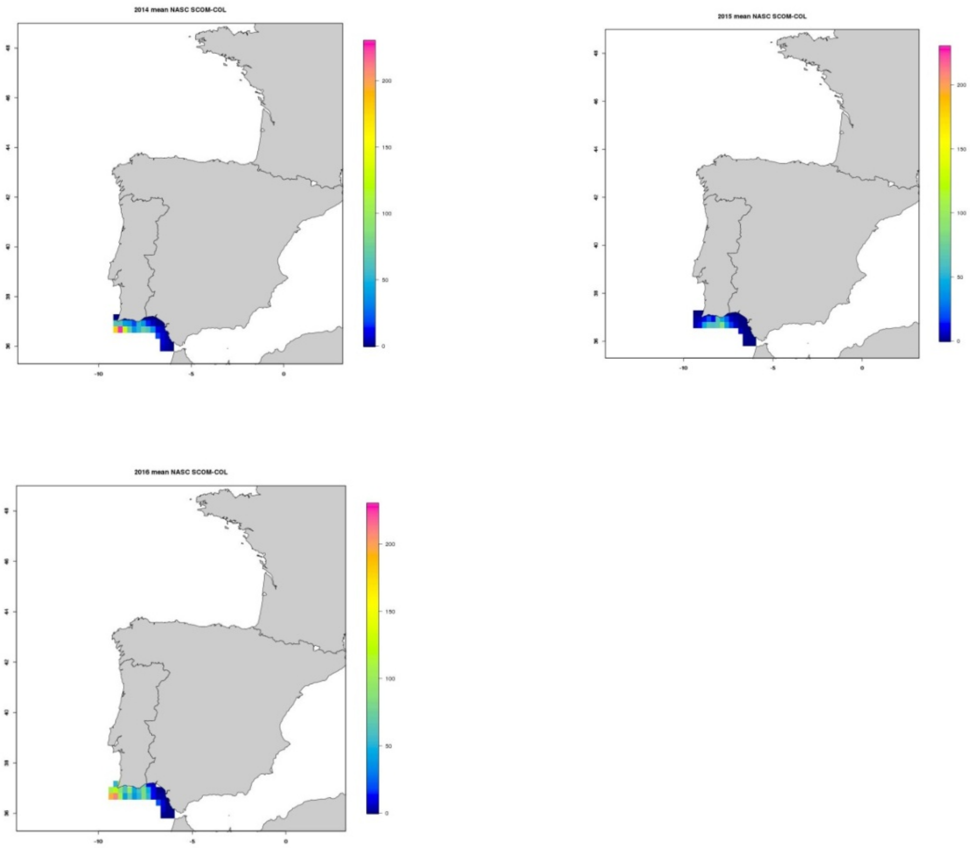


Figure 3.3.1.3.2. *ECOCADIZ-RECLUTAS* survey series. *S. colias*. Grid maps showing the spatial distribution of the backscattering energy (nautical area scattering coefficient, NASC, in m^2 nmi^{-2}) attributed to chub mackerel. The 2012 survey only covered the Spanish waters and is not represented in this figure.

Table 3.3.1.3.2 and Figure 3.3.1.2.3 show the overall and regional acoustic estimates of chub mackerel abundance and biomass in the autumn acoustic surveys. This series is too short to identify any trend. Nevertheless, as described above for their summer counterparts, the bulk of the estimated population of the species is still being recorded off Portugal. During the available series (excepting the 2012 partial estimate), the population levels have oscillated between 65 and 297 million fish, in 2015 and 2016, respectively. The estimated biomasses ranged between 5683 and 17471 t, in 2015 and 2014, respectively. As described below, the occurrence of a population dominated by very small fish in 2016 resulted in the absence of correspondence between the peak in abundance recorded that year with a concomitant peak in biomass.

Table 3.3.1.3.2. *ECOCADIZ-RECLUTAS* survey series. *S. colias*. Acoustic estimates of abundance (in million fish) and biomass (in tones) by country and the whole surveyed area (Sub-division 9a South). Note that the 2012 survey only covered the Spanish waters.

Year	**ABUNDANCE (millions)**			**BIOMASS (t)**		
	PT	**ES**	**TOTAL**	**PT**	**ES**	**TOTAL**
2012		157			11155	
2013						
2014	105	43	148	11791	5679	17471

2015	54	11	65	4317	1366	5683
2016	231	67	297	10269	3420	13689

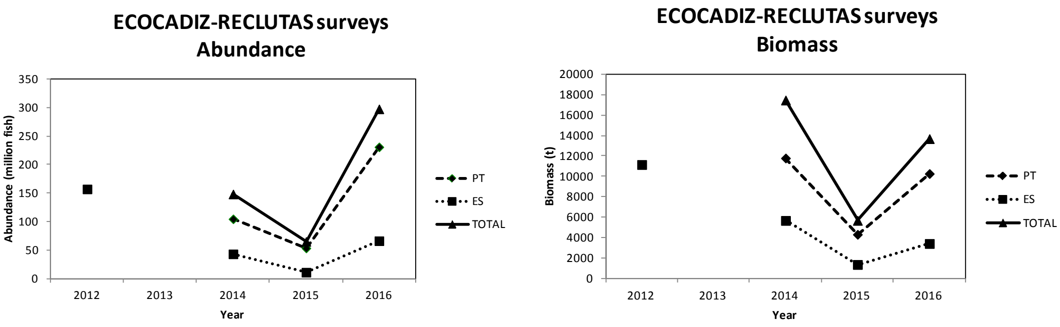
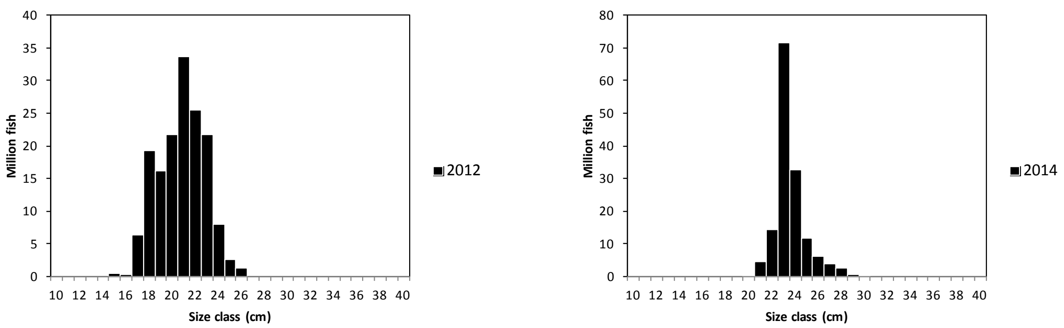


Figure 3.3.1.3.3. *ECOCADIZ-RECLUTAS* survey series. *S. colias*. Acoustic estimates of abundance (in million fish) and biomass (in tones) by country and the whole surveyed area (Sub-division 9a South). Note that the 2012 survey only covered the Spanish waters.

The overall size range of chub mackerel in autumn oscillated between 12 and 31 cm (Figure 3.3.1.3.4). The size composition of the estimated populations each year showed a relatively composite distribution, but the LFD in 2014 (modal size at 23 cm). First modal component in composite LFDs oscillated between 15 and 20 cm, with this modal component being the dominant one in the estimated populations in 2015 (mode at 20 cm) and 2016 (mode at 15 cm, with a LFD resembling the one previously estimated in summer that year). The second modal component was located between the 21 and 24 cm size classes.

Age structure in autumn is still evidencing a population mainly composed by juvenile and young fish (age 0 and 1 fish; Figure 3.3.1.3.5) and the absence of fish older than 3. Very small age-0 fish are abundant in the autumn 2016 population, involving a decrease of the overall mean size and weight as compared with previous years (Figure 3.3.1.3.6).



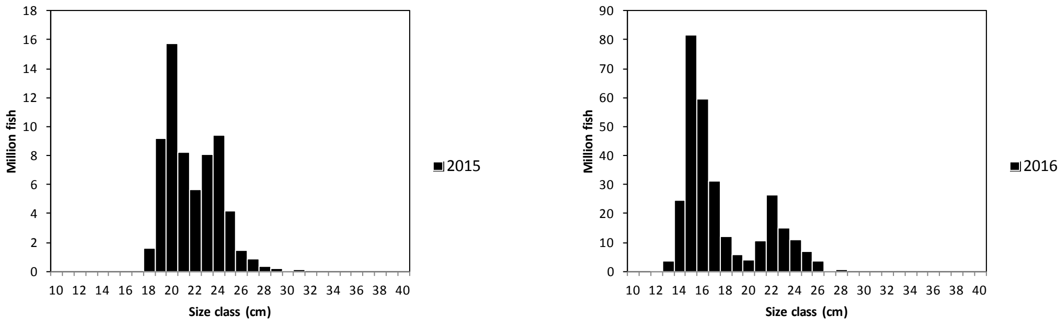


Figure 3.3.1.3.4. *ECOCADIZ-RECLUTAS* survey series. *S. colias*. Acoustic estimates of abundance (in million fish) by size class (in cm) for the whole surveyed area (Sub-division 9a South). Note that the 2012 survey only covered the Spanish waters. Also note the different scale of the *y* axis.

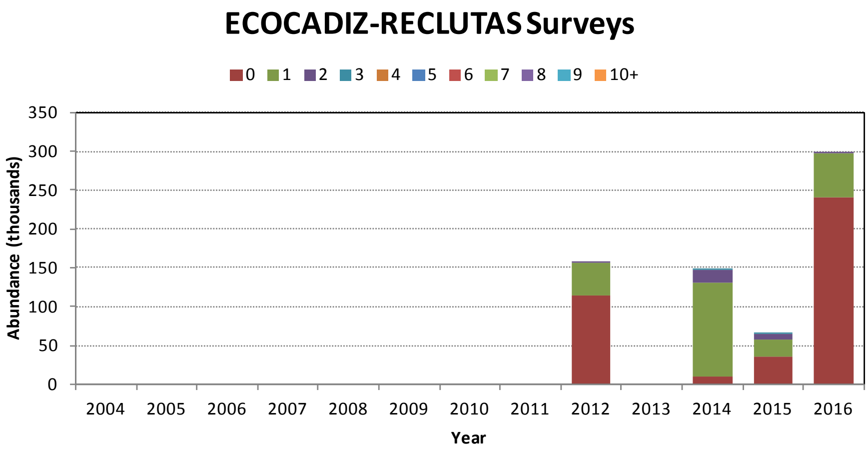
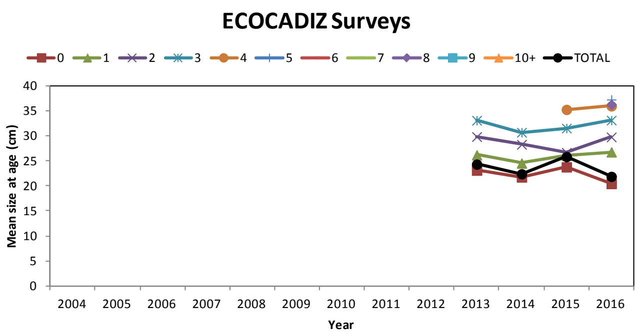


Figure 3.3.1.3.5. *ECOCADIZ-RECLUTAS* survey series. *S. colias*. Acoustic estimates of abundance (in million fish) by age group for the whole surveyed area (Sub-division 9a South). Age structure estimated by applying the available ALKs for the second semester from pooled commercial and surveys samples from the Sub-divisions 8c and 9a N.



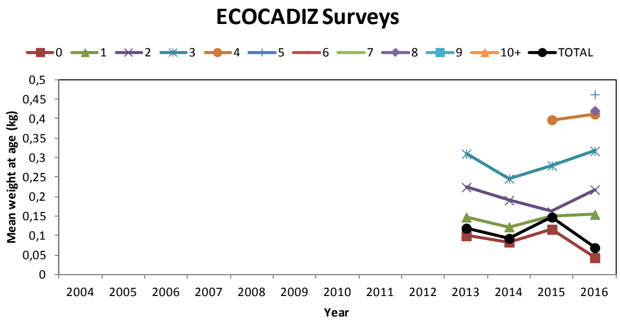


Figure 3.3.1.3.6. *ECOCADIZ-RECLUTAS* survey series. *S. colias*. Mean size (in cm, upper panel) and mean weight (in k, lower panel) by age group for the whole surveyed area (Sub-division 9a South). Age structure estimated by applying the available ALKs for the second semester from pooled commercial and surveys samples from the Sub-divisions 8c and 9a N.

3.3.2 Bottom Trawl Surveys (1984-2016)

3.3.2.1 DEMERSAL surveys (9.a North and 8.c areas): Autumn 1982-2016

The time series of the abundance in biomass and number of chub mackerel on the ground fish surveys on the Northern Shelf is shown on figure 3.3.2.1.1. For most of the time series its presence in the surveys has been scarce, with a couple of small blooms before 2013, and a more remarkable increase in the last two years.

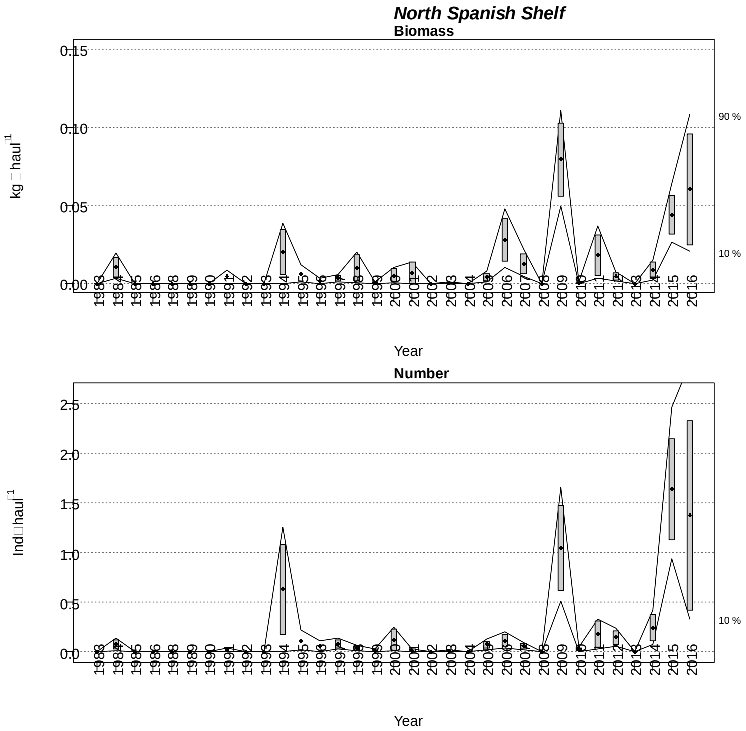


Figure 3.3.2.1.1. Chub mackerel abundance in biomass and numbers time series on the North Spanish Shelf groundfish survey.

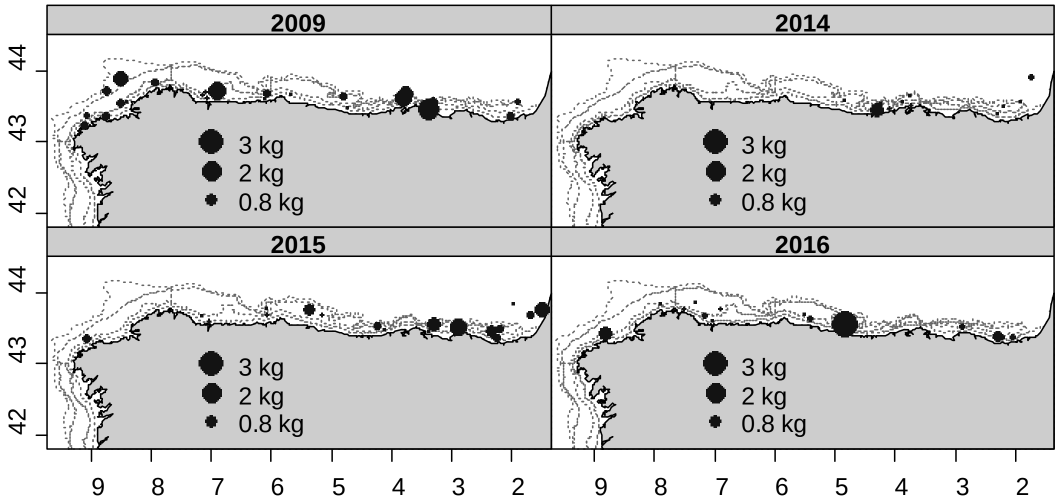


Figure 3.3.2.1.2. Geographical distribution in Kg./ 30' haul of chub mackerel on North Spanish shelf in years with large abundance in the survey time series as shown on Figure 3.3.2.1.1.

Figure 3.3.2.1.2 presents the geographical distribution of chub mackerel on the northern Iberian shelf on 4 years with large abundances in the time series. No clear pattern is evident for these results, only that the species is distributed mainly close to the coast on shallow grounds, though in 2009 some fish appeared further on the Galician shelf, while on the Cantabrian sea (8.cEast) they tend to be closer to the coast.

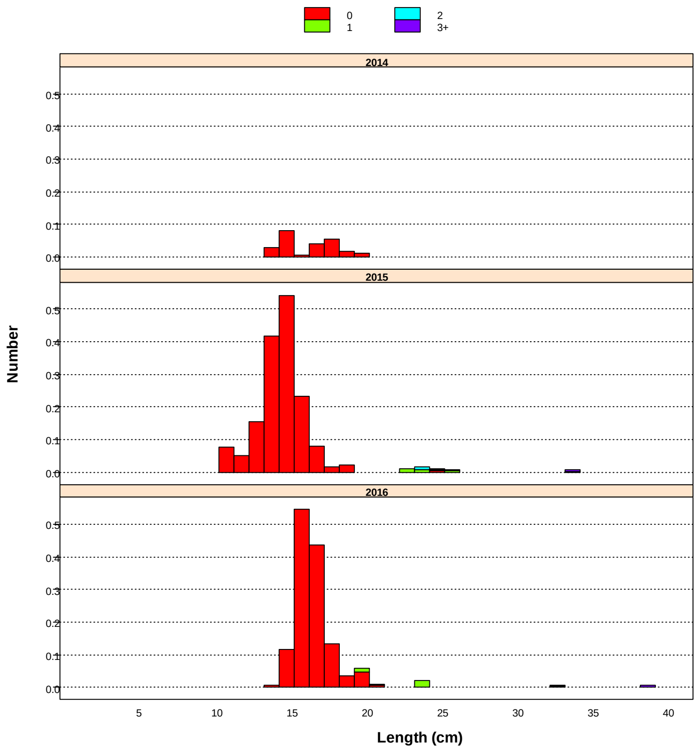


Figure 3.3.2.1.3. Stratified length distribution with its age contribution to each age class, plus age at 3+ in No./ 30' haul of Chub mackerel on North Spanish shelf in the last three years 2014-2016.

Figure 3.3.2.1.3 presents the stratified length distribution of *S. colias* showing the contribution of each age class to each length class using a 3 yrs. + age length key, given the low abundance of older age classes. From these results is evident that the main age classes sampled by the trawl gear during these surveys are age 0, with a very low presence of older ages.

3.3.2.2 ARSA surveys (9.a South): Spring 1993-2016.

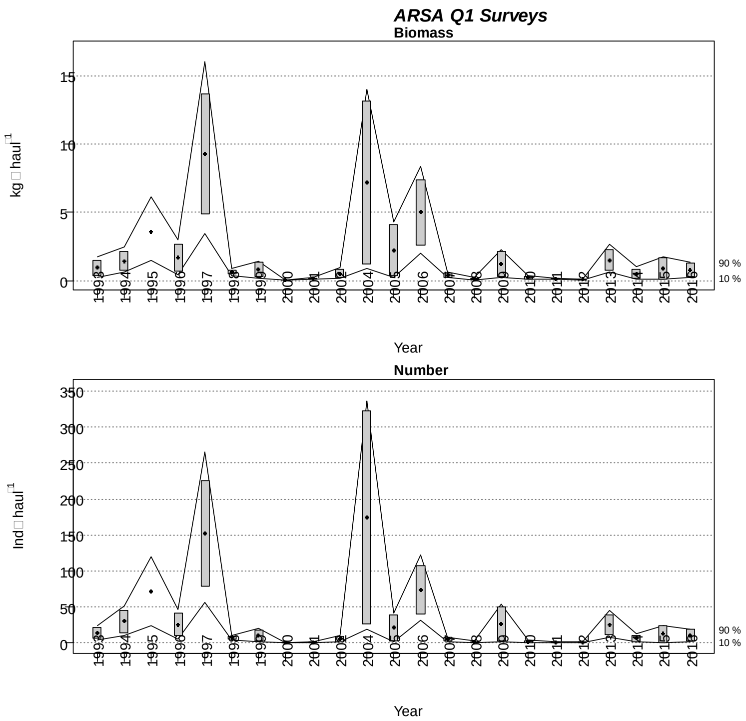


Figure 3.3.2.2.1. Chub mackerel abundance in biomass and numbers time series on the *Gulf of Cadiz (ARSA) Q1 survey.*

The time series of the abundance in biomass and number of chub mackerel on the ground fish surveys on the 1st quarter ARSA groundfish surveys is shown on figure 3.3.2.2.1. In most of the years its presence in the surveys has been scarce, with some remarkable blooms in 1997 and 2004; and relatively low but more stable abundances in the last four years from 2013 to 2016.

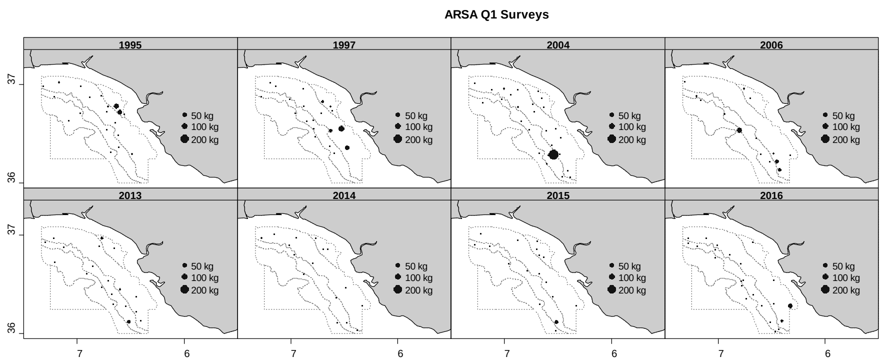


Figure 3.3.2.2.2. Geographical distribution in Kg./ 60' haul of Chub mackerel on 1st quarter Gulf of Cadiz ARSA ground fish surveys in years with large abundance in the survey time series as shown on Figure 3.3.2.2.1.

Figure 3.3.2.2.2 presents the geographical distribution of *S. colias* on the Gulf of Cadiz shelf on 8 years with large abundances in the time series. No clear pattern is evident and constant in these results. Only it appears that the species is distributed closer to Gibraltar strait and in deeper grounds that in the case of the Northern shelf. In 1995 these pattern was different, with most of the, nevertheless low, catches caught close to the coast on the shallower strata.

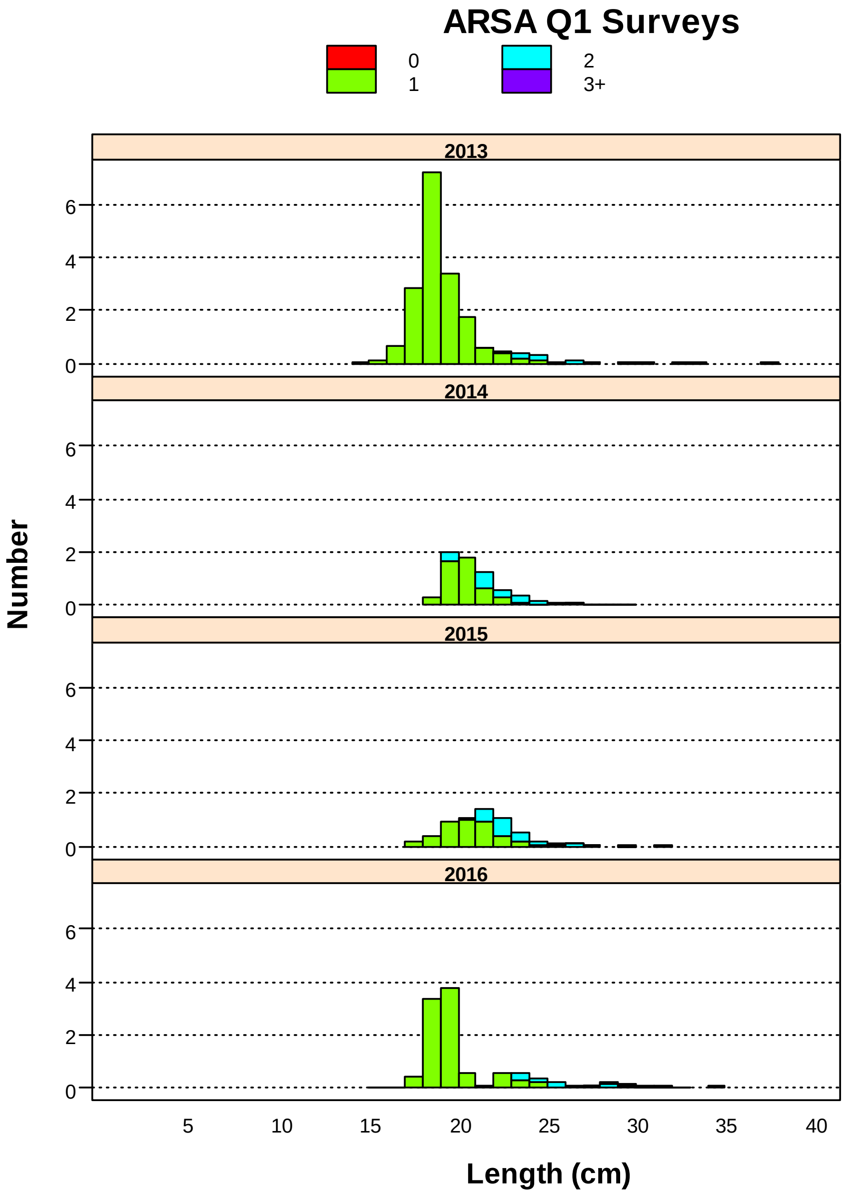


Figure 3.3.2.1.3. Stratified length distribution with its age contribution to each age class, plus age at 3+ in No./ 60' haul of Chub mackerel on 1st quarter Gulf of Cadiz ARSA surveys on the last three years 2014-2016.

Figure 3.3.2.2.3 presents the stratified length distribution of chub mackerel on 1st quarter Gulf of Cadiz groundfish surveys showing the contribution of each age class to each length class using a 3 yrs. + age length key, given the low abundance of older age classes. Most of the individuals sampled are from age 1, while on the results shown in Figure 3.3.2.3.3 they belong to age class 0, although the length distributions do not show clear differences with the length distributions found on the 4th quarter. In this respect is important to note that the ALKs used are those coming from the commercial samplings by semester, and not those from the actual surveys, given the actual otoliths were too scarce to use them to convert the length data to age.

3.3.2.3 ARSA surveys (9.a South): Autumn 1997-2016

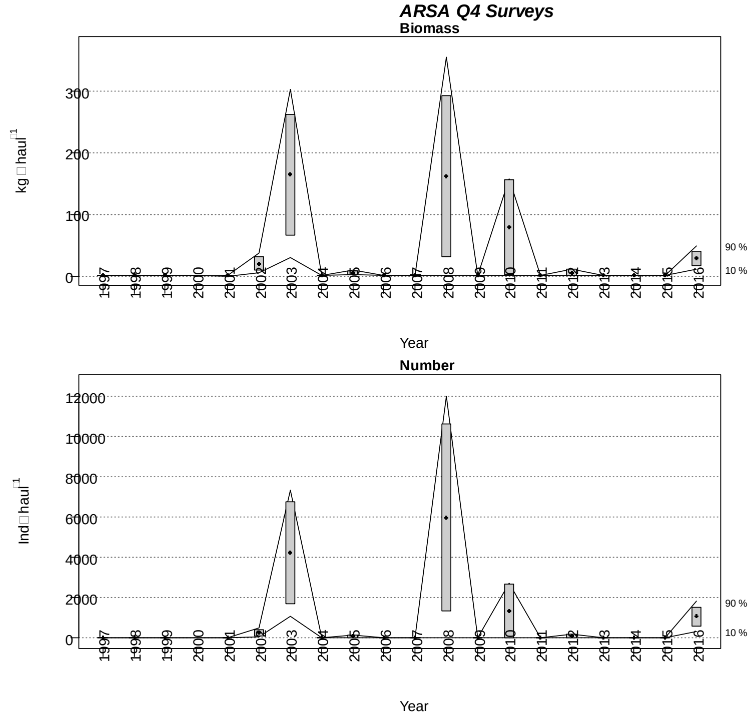


Figure 3.3.2.3.1. Chub mackerel abundance in biomass (kg/60’ haul) and numbers (no./60’ haul) time series on the *Gulf of Cadiz (ARSA) Q4 survey.*

The time series of the abundance in biomass (kg/ 60’ haul) and number (no./ 60’ haul) of chub mackerel on the ground fish surveys on the 4th quarter ARSA groundfish surveys is shown on figure 3.3.2.3.1. As in the case of the 1st quarter survey, most of the years the presence of chub mackerel in the surveys has been scarce, with some remarkable blooms in 2003 and 2008; and low in the rest of the series, including the last three years from 2013, although in 2016 a small peak has been found.

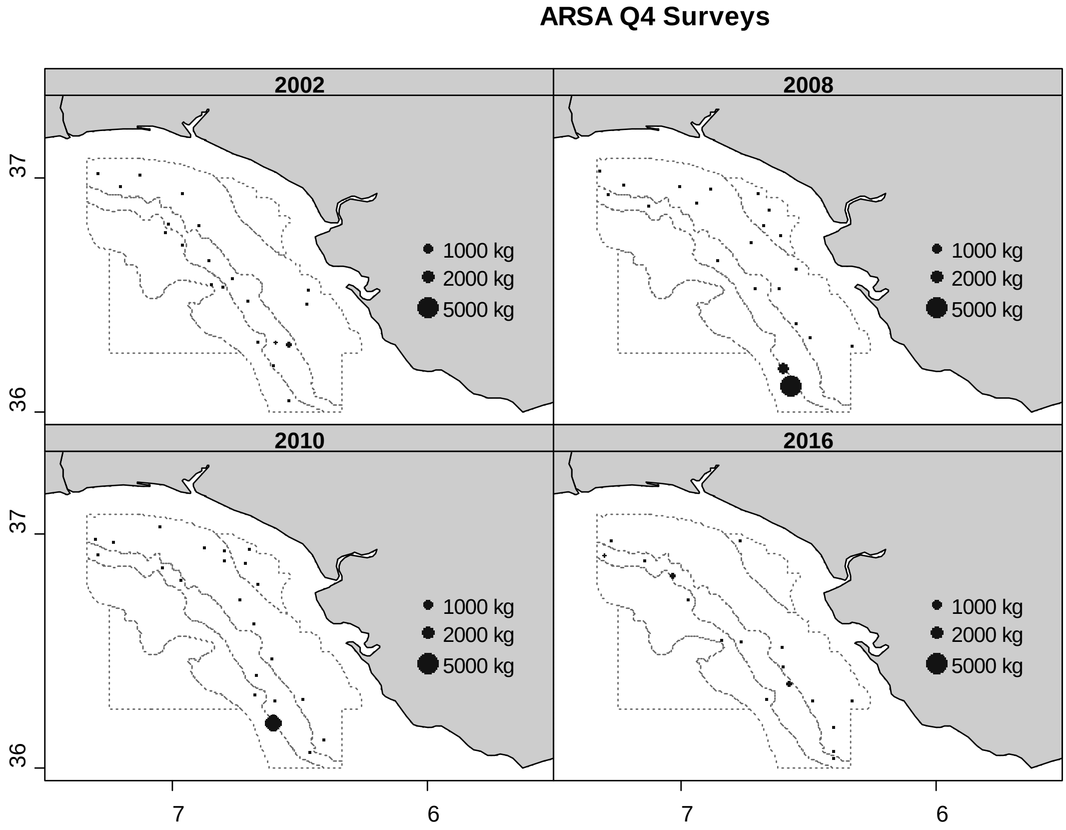


Figure 3.3.2.3.2. Geographical distribution in Kg./ 60' haul of Chub mackerel on 4th quarter Gulf of Cadiz ARSA groundfish surveys in years with large abundance in the survey time series as shown on Figure 3.3.2.3.1.

Figure 3.3.2.3.2 presents the geographical distribution of chub mackerel on the Gulf of Cadiz shelf on 8 years with large abundances in the time series. No clear pattern is evident and constant in these results. Only in this case the years with large abundances (2008 and 2010) the species was clearly distributed closer to Gibraltar strait and in deeper grounds that in the case of the Northern shelf or in 1st quarter on the Gulf of Cadiz.

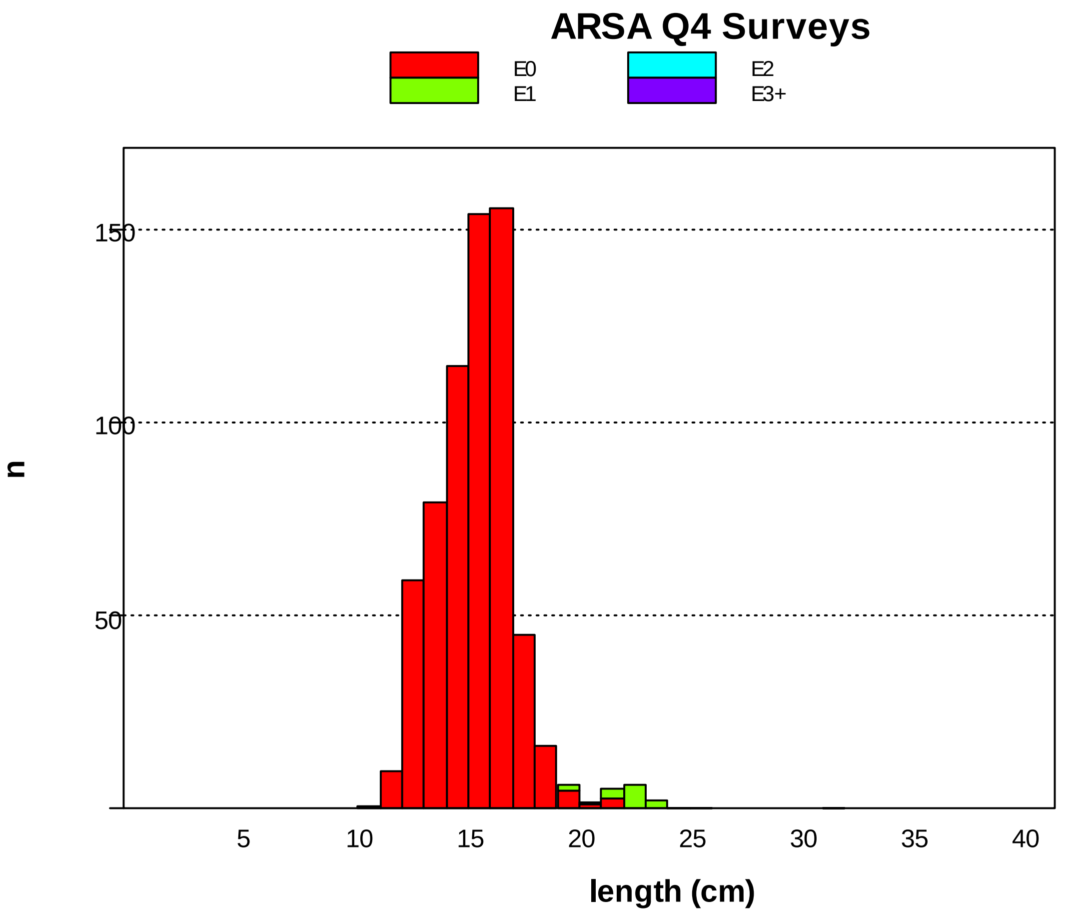


Figure 3.3.2.3.3. Stratified length distribution with its age contribution to each age class, plus age at 3+ in No./ 60’ haul of Chub mackerel on 4th quarter Gulf of Cadiz ARSA surveys on the last year survey (2016).

Figure 3.3.2.3.3 presents the stratified length distribution of chub mackerel on 4th quarter Gulf of Cadiz groundfish surveys showing the contribution of each age class to each length class using a 3 yrs. + age length key, given the low abundance of older age classes. As mentioned above, most of the chub mackerel individuals caught during 4th quarter survey belong to age 0, with few age 1 individuals. Unfortunately the age readings and the information on ages were available only from 2011, because it would have been interesting to check the cohorts and the ages composition in 2003 4th quarter and 2004 1st quarter, given in both surveys there was a relative (to the close years) peak of chub mackerel, although the magnitude is clearly different (4236 inds. per 60’ haul in 2003 4th quarter and around 174 inds. in 2004 the in the 1st quarter.

4. Discussion and conclusion

Fisheries

Since 2010 chub mackerel landings have notably increased on about 40% in relation to the previous periods. At present, round 33 thousands tones on average are annually caught, mainly by purse seiners, which represents a new fishery that partially compensate the actual low yield of the sardine one, given the low productivity of the sardine Ibero-Atlantic stock. This decrease in sardine landings together with new market opportunities, specially as supply for the canning industry that complements its traditional use as bait for other fisheries, as well as a possible increase of the chub mackerel availability, as suggested by Correia (2016), could explain this significant increase in catches. However, mean first sale price is still low as compared with that of the Atlantic mackerel. Figures 4.1 and 4.2 show the evolution of the Portuguese catches. There was a first period of high catches in the seventies, coincident with a decrease in sardine landings. The actual level of chub mackerel catches is higher that the precedent peak and also coincides with an important drop in sardine landings.

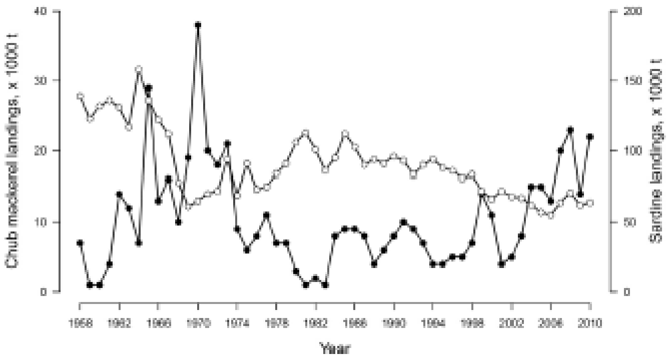


Figure 4.1 Portuguese sardine and chub mackerel landings from 1958 to 2010 (from Martins et al., 2013)

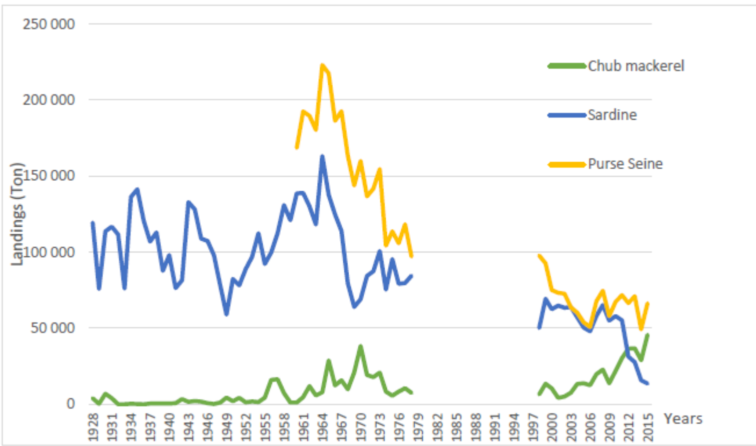


Figure 4.1 Portuguese sardine and chub mackerel landings from 1958 to 2015. Data between 1979 and 1997 should be observed in the previous plot (from Correia, 2016)

Thus, the geographical distribution of chub mackerel catches, with the bulk concentrated in Division 9.a and in the westernmost part of 8.c would be also explained by this higher availability in the Atlantic area and not only by the decrease of the sardine yield. On the other hand, there is still no signal of such increase at the inner part of the Bay of Biscay as both catches and survey estimates remain at same order of magnitude as observed in previous periods. Summer time is the main fishing period, which is later than that of the Atlantic mackerel, whose main fishing period is late winter-earlier spring..

Mean length shows a geographical trend with the smallest fish being caught in southern part and the biggest in the Cantabrian Sea. Besides, in this area mean length has also decreased, although is still higher than those of the other areas. The increasing availability of young fish along the year can explain this trend. In the same way, the differences observed in the shape of the frequency length distribution between 9.a and 8.c.would be related with the prevalence of 9.a as nursery area against the prevalence of 8.c as spawning area.

Biological aspects

Length-weight relationships of chub mackerel indicate a tendency towards positive-allometric growth (increase in relative body thickness or plumpness) as most of the b values are above 3.0. These relationships do not show any trend in the studied period and there are no differences between years.

Spawning period of chub mackerel mainly extends between March and July with a peak in June, although some individuals appear to be in active stages throughout the year. The active stages shown during autumn and winter in 8.c corresponded to a post-spawning maturity stage. A possible explanation would be a misallocation of the maturity stage. Instead stage 6 (resting), the gonads would be allocated as post-spawned (stage 5), thus still in spawning activity. Differences between late post-spawner and resting fish are difficult to elucidate macroscopically. Therefore these gonads should be microscopically scrutinized in orther to avoid misinterpretations on the maturity stage. Further investigations at microscopic level should be conducted in order to clarify the annual spawning activy of chub mackerel.

In Division 9.a south, studies on the spawning period have not yet been carried out, but probably would be, as in the nearby areas, during the first semester(in Madeira Island, between January and April -Vasconcelos, 2006, Vasconcelos et al., 2011-; in Portugal, between Febuary and May -Martins, 1996-). On the other hand, size composition in 9.a South suggests a possibility of a nursery area rather than a spawning one. Martins (2013) suggests that, given the increasing size/age gradient from the Portugal-Cadiz area to the Moroccan waters, the Gulf of Cadiz would be a nursery area of a large population spawning in Moroccan waters, which supports our findings.

A temporal gradient in the spawning period is observed along east Atlantic waters when considering previous studies (Navarro et al, 2014), being from November to February in lower latitudes (Canary Islands) up to from March to July in northern Iberian waters. This gradient could be related to temperature as the spawning of chub mackerel occurs when water temperature is at least 10ºC and most often when it is 15 to 20ºC (Castro and Santana, 2000), as occurs in other migratory species such as mackerel (ICES, 2016).

The L50 values of around 25 cm (and A50= 1.9 years) obtained in 8.c and 9.a North are in the range of those estimated in previous studies in the same area(Navarro et al., 2014), but smaller than those from other parts of Iberian waters (Martins, 1996; Lucio, 1997). This may be due to differences in environmental conditions among the areas and the different period when each study took place. And also could be question of the sampling in the different areas of the Iberian waters, since as we have seen different sizes of fish prevail more in some areas than in others. In general, higher L50 values are obtained in Iberian waters (Martins, 1996; Lucio, 1997; Navarro et al., 2014; Canseco, 2016; this WD) 8than in Atlantic Islands (Nespereira, 1993; Vasconcelos, 2006; Vasconcelos et al., 2011). Being the Bay of Biscay the northern boundary of this species distribution and having colder waters, the spawning conditions present in this area later in time.

The growth parameters estimated by Canseco (2016; K=0.40, L_∞=39 cm) are relatively close to those estimated by Velasco et al. (2011; K=0.27, $L\infty$=43 cm) in the Gulf of Cadiz, and very close to those estimated by Navarro et al. (2014b; K=0.66. $L\infty$=38 cm) in the Bay of Biscay. $L\infty$ value in the study areas is similar to that of ~40 cm estimated in other Spanish Mediterranean waters (Perrota, 2005; Velasco, 2011). Values close to 43-44 cm were estimated in the Gulf of Cadiz and Moroccan waters (Velasco, 2011, Krivospitchenko, 1979). In the Atlantic areas, the highest length and growth rates at older ages have been observed in the Azores Islands (Carvalho et al., 2002).

In the Gulf of Cadiz, Canseco's study evidenced a relationship between maturity stage and condition status for *S. colias*, with maturing individuals showing an increased body condition. In general, most of the analyzed individuals in the summer surveys had only small quantities of food in their stomachs. Similar results were also found by Torres (2013) and Torres et al. (2013), sampling individuals of both *Scomber* species caught in spring and autumn during bottom trawling surveys in the study area. According to others studies performed in the Narraganset Bay and Mauritania, both species are nocturnal feeders (Maigret et al., 1986; Macy et al., 1998), a fact which may condition both the Canseco's and Torres' findings since the fishing hauls providing the biological samples took place at daily hours.

According to this study (see section 3.2.5.), the most suitable area and period to estimate mean weight at age in the stock for chub mackerel is the Cantabrian Sea (Division 8.c) during the second quarter. It could be the main spawning area and also coincides with the spawning period. Besides, the acoustic-trawl survey PELACUS covers this area in spring allowing the whole spatial distribution be sampled.

Stock structure

The results show that the age structure of chub mackerel in Atlantic Iberian waters during 2011-2016 was mainly composed by fish between 0-6 years old, with prevalence of ages 1 to 3. Individuals up to 14 years old have been captured but in small proportions.

The age structure in catches shows that juveniles (age 0-2) are mainly distributed in Division 9.a and adults (> 2 years old) mainly in Division 8.c. Nevertheless, since 2014, juveniles have also occurred in Division 8.c, mainly in the second part of the year, suggesting an increase of the nursery and recruitment areas in the last years towards the Cantabrian Sea. Whether this increase is a consequence of the strength of the last recruitment or a shift of the recruitment and nursery areas is still a matter of concern which will require further studies. It should be also noted that in the French area results of the 2017 PELACUS survey has estimated a large amount of young fish. The partial coverage of the French shelf and the shortened of the records do not allow confirm this area as another nursery. The analysis of the whole time series PELACUS (2013-17), although short, has shown the strength of the 2015 and 2016 cohorts in 9a and still the prevalence of 8c as spawning area.

On the other hand, acoustic abundance estimates in summer and autumn surveys (either by length class or age group) in the Gulf of Cadiz (9.a South) agree with the catch at length/age matrices, suggesting its prevalence as recruitment and nursery area, corroborating previous findings This age structure together with the spawning period probably located between January and April as in Madeira Island(Vasconcelos, 2006; Vasconcelos et al., 2011) could explain the lack of of mature individuals, as evidenced by Canseco (2016).

Spatial Distribution

While in the Gulf of Cadiz chub mackerel is one of the most important pelagic fish species, in the northern areas and at least in spring time, the pelagic community is dominated by mackerel, bogue (*Boops boops*) and horse mackerel, with sardine and anchovy with a scarce presence of chub mackerel. The younger fish are mainly distributed in coastal waters (20-90 m depth),. In the Gulf of Cadiz is observed throughout the surveyed area, with main location between Algarve waters and the Guadiana river estuary (36.9° to 37.4° and -8.5° to -7°). Nevertheless, in the most recent years the spatial distribution expanded towards deeper waters (ca. 115 m) together with a slight shrink in the spatial distribution along de coast, which seems to be coincident with the decreasing observed in the abundance between 2010 and 2015 (Canseco, 2016; this WD).

The increasing trend in catches and in the acoustic abundance estimates are in agreement with the forecast on the increasing trend of the temperature predicted for NorthEast Atlantic waters and its influence on the potential habitats for chub mackerel (Kaschner et al., 2016). As shown in figure 4.3, chub mackerel is likely to occur in medium term in waters up to Celtic and Irish Seas and in the British Channel.

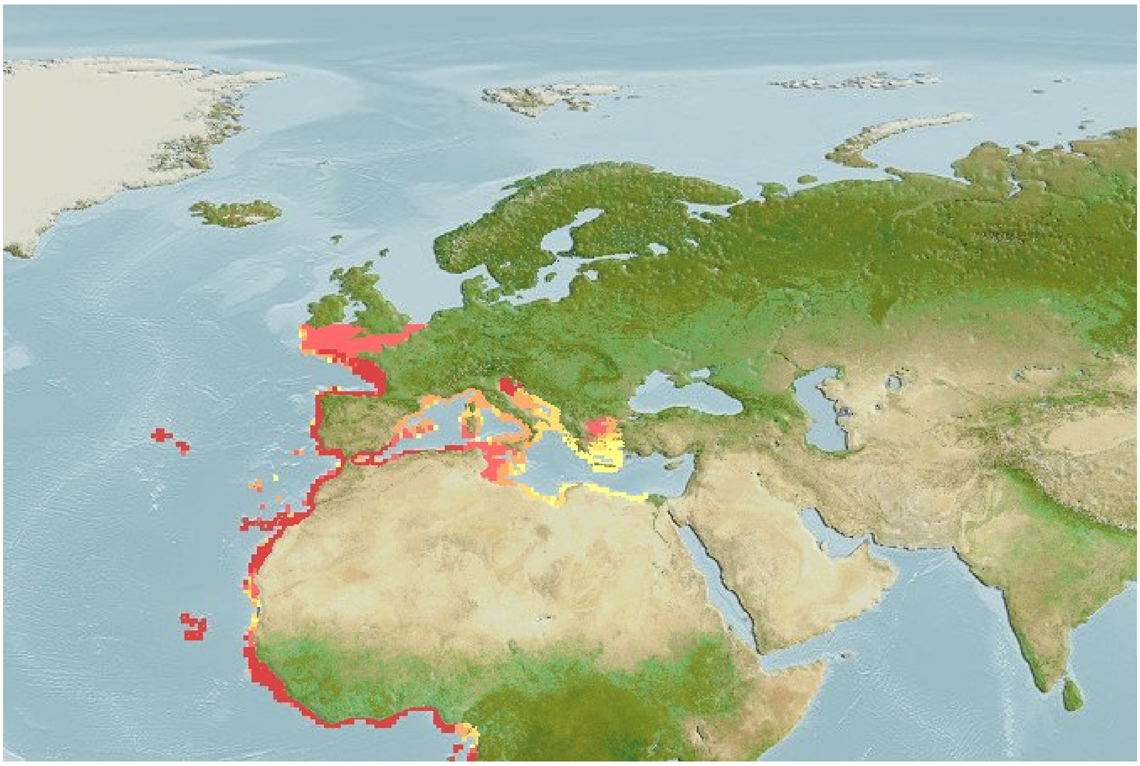


Figure 4.3. Predicted potential area of Chub Mackerel. *Color palette, from light yellow to red, is showing the relative probability of occurrence* (Source: Reviewed distribution maps for Scomber colias (Atlantic chub mackerel), with modelled year 2100 native range map based on IPCC A2 emissions scenario. www.aquamaps.org, version of Aug. 2016. Web. Accessed 2 Sep. 2017.)

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Annex 1

Table 1. Chub Mackerel. Catch numbers (‘000s) -at-age by area for 2011-2016

Quarter 1	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1		35	64	0	64		90	104	0	104	76	0	76	56	132	1024	19	1043	0	1043	357	6	363	0	363	523	0	523	0	523
2		213	387	2	388		578	669	1	671	471	0	471	22	492	1091	347	1439	75	1514	1024	1415	2439	63	2502	2791	410	3201	65	3266
3		259	470	279	749		1664	1928	215	2143	59	11	70	60	129	7	42	49	124	174	60	8759	8819	3006	11825	211	3032	3243	141	3384
4		18	32	473	505		207	240	917	1157	4	92	96	298	394	0	1	1	211	212	7	2491	2499	1995	4494	22	762	784	83	866
5		0	0	517	517		28	32	666	698	0	317	317	883	1200	0	0	0	381	381	0	151	151	543	694	4	136	139	86	226
6		0	0	248	248		14	16	189	205	0	131	131	386	517	0	0	0	484	484	0	0	0	221	221	0	53	53	80	133
7		0	0	275	275		10	12	117	129	0	23	23	102	125	0	0	0	139	139	0	0	0	262	262	0	9	9	83	92
8		0	0	268	268		4	5	38	43	0	14	14	69	83	0	0	0	115	115	0	0	0	278	278	0	9	9	94	103
9		0	0	96	96		0	0	0	0	0	7	7	50	57	0	0	0	115	115	0	0	0	0	0	0	0	0	0	0
10		0	0	38	38		0	0	0	0	0	3	3	31	34	0	0	0	166	166	0	0	0	0	0	0	0	0	0	0
11		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	110	110	0	0	0	0	0	0	0	0	0	0
12		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	14	14	0	0	0	0	0	0	0	0	0	0
15+		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total N		524	953	2196	3149	0	2594	3005	2144	5149	609	597	1206	1957	3163	2122	409	2532	1934	4465	1449	12822	14271	6368	20639	3550	4410	7960	632	8592
Catch (t)		99	180	1149	1329		616	714	977	1691	96	332	428	1083	1511	212	67	279	954	1232	182	3038	3220	2392	5612	560	1557	2117	318	2435
SOP (t)		99	180	1149	1329		616	714	977	1691	96	332	428	1083	1511	212	67	279	954	1232	183	3038	3221	2392	5612	560	1557	2117	318	2435
SOP (%)		100	100	100	100		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Quarter 2	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1		2492	5158	0	5158		7	20	0	20	1728	571	2299	0	2299	2271	45	2315	0	2315	391	6	397	0	397	1046	1075	2121	0	2121
2		2187	4528	0	4528		103	298	2	300	10772	1344	12116	3	12119	13550	7035	20585	6002	26587	5289	1402	6691	28	6719	7526	11428	18954	1246	20201
3		3863	7997	1007	9004		1273	3688	270	3958	1348	248	1596	243	1839	270	1660	1930	1991	3921	7820	8679	16498	4955	21453	3954	927	4881	6015	10896
4		577	1194	1651	2846		587	1702	1149	2851	94	194	288	937	1225	9	80	89	681	770	2127	2469	4595	4687	9282	1152	83	1236	2971	4207
5		110	229	988	1216		253	733	834	1567	0	307	307	1782	2089	2	0	2	705	708	32	149	181	2041	2222	223	15	238	751	989
6		16	33	240	273		67	195	237	433	0	90	90	578	668	0	0	0	498	498	0	0	0	926	926	90	2	92	494	586
7		16	33	190	223		34	100	147	247	0	11	11	104	115	0	0	0	73	73	0	0	0	1124	1124	28	1	29	367	396
8		10	21	192	213		14	41	47	88	0	5	5	56	61	0	0	0	47	47	0	0	0	830	830	28	1	29	374	403
9		4	8	102	110		0	0	0	0	0	2	2	41	43	0	0	0	47	47	0	0	0	0	0	0	0	0	0	0
10		0	0	87	87		0	0	0	0	0	0	0	19	19	0	0	0	71	71	0	0	0	0	0	0	0	0	0	0
11		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	34	34	0	0	0	0	0	0	0	0	0	0
12		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	13	13	0	0	0	0	0	0	0	0	0	0
15+		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total N	0	9275	19202	4457	23659	0	2339	6779	2686	9465	13942	2772	16714	3764	20478	16102	8820	24922	10164	35086	15659	12705	28364	14590	42954	14047	13533	27580	12219	39799
Catch (t)		1697	3512	2041	5553		784	2271	1224	3495	2195	622	2816	1923	4739	2094	1779	3873	2696	6569	2914	3010	5924	6331	12254	3214	2255	5469	4716	10185
SOP (t)		1697	3512	2041	5553		784	2271	1224	3496	2195	622	2816	1923	4739	2094	1779	3873	2696	6569	2914	3010	5924	6331	12255	3214	2255	5469	4716	10185
SOP (%)		100	100	100	100		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Quarter 3	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		3	5	0	5		0	0	0	0	462	0	462	0	462	6892	0	6892	0	6892	446	0	446	59	505	452	641	1093	2887	3979
1		2867	4506	387	4892		13	25	0	25	21589	7666	29255	6	29261	12931	6237	19168	406	19574	11580	15778	27358	9099	36456	24029	4261	28290	4845	33135
2		13494	21208	433	21640		1009	1981	40	2020	4536	11699	16236	145	16380	10234	29441	39676	11715	51390	7066	8587	15653	3971	19624	8157	10380	18537	8341	26877
3		6480	10185	8010	18195		9412	18482	1551	20032	148	2426	2575	689	3264	1516	8810	10326	8377	18703	2774	8820	11594	3054	14648	1675	4058	5733	5087	10820
4		75	118	8779	8897		3962	7780	4017	11797	0	581	581	939	1519	83	450	533	406	939	26	1008	1034	199	1233	220	540	760	1055	1815
5		1	1	1317	1318		97	191	1108	1300	0	111	111	900	1011	6	9	15	15	30	1	285	286	70	356	23	44	68	447	515
6		0	0	669	669		7	13	318	331	0	14	14	328	342	1	0	1	4	4	0	74	74	44	118	7	17	24	355	379
7		0	0	201	201		0	0	18	18	0	2	2	438	440	1	0	1	4	4	0	0	0	0	0	0	0	0	269	269
8		0	0	99	99		0	0	0	0	0	1	1	411	412	1	0	1	4	4	0	0	0	0	0	3	3	6	289	295
9		0	0	11	11		0	0	0	0	0	0	0	397	397	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10		0	0	5	5		0	0	0	0	0	0	0	358	358	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15+		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total N	0	22920	36022	19910	55933	0	14500	28472	7051	35523	26736	22500	49236	4611	53847	31663	44948	76611	20929	97540	21892	34553	56445	16495	72940	34565	19944	54510	23574	78084
Catch (t)		4197	6596	9203	15799		5347	10499	3213	13712	3651	5090	8741	2936	11676	3952	9778	13731	5452	19183	4342	9449	13791	3859	17650	5318	4857	10175	6116	16291
SOP (t)		4197	6596	9203	15799		5347	10499	3613	14112	3651	5090	8741	2936	11677	3952	9778	13731	5452	19183	4342	9449	13791	3858	17649	5318	4857	10176	6116	16292
SOP (%)		100	100	100	100		100	100	112	97	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Quarter 4	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N		8.c	All
0		2	2	0	2		10085	10349	0	10349	9	0	9	0	9	223	0	223	0	223	19	0	19	0	19	633	4356	4990	338	5327
1		272	321	0	321		12852	13188	0	13188	425	4850	5275	137	5412	832	3180	4012	0	4012	2626	1193	3819	566	4385	3107	9606	12713	1332	14045
2		1502	1772	13	1784		438	449	58	507	89	4051	4141	641	4782	764	9193	9957	865	10821	1363	649	2012	857	2868	151	1463	1615	3151	4766
3		2837	3346	1454	4800		133	136	2278	2414	3	117	120	1432	1552	154	1241	1395	1611	3007	635	667	1301	1304	2606	0	2067	2067	2352	4420
4		504	594	2246	2840		7	7	5900	5908	0	0	0	1107	1107	9	65	74	1556	1630	6	76	82	263	345	0	564	564	617	1181
5		26	31	535	566		0	0	1628	1628	0	0	0	732	732	1	0	1	1056	1057	1	22	22	174	196	0	134	134	272	406
6		3	3	285	288		0	0	466	466	0	0	0	170	170	0	0	0	529	529	0	6	6	207	212	0	67	67	231	298
7		1	1	187	188		0	0	26	26	0	0	0	70	70	0	0	0	406	406	0	0	0	0	0	0	9	9	188	197
8		1	1	155	156		0	0	0	0	0	0	0	38	38	0	0	0	416	416	0	0	0	0	0	0	15	15	195	210
9		0	0	25	25		0	0	0	0	0	0	0	17	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10		0	0	9	9		0	0	0	0	0	0	0	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15+		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total N	0	5146	6070	4909	10979	0	23514	24129	10357	34486	526	9018	9544	4349	13893	1983	13679	15662	6439	22100	4650	2612	7261	3371	10632	3892	18282	22174	8676	30849
Catch (t)		1400	1652	2663	4315		2629	2697	4719	7417	72	1707	1779	1860	3638	248	2574	2821	3693	6514	945	714	1659	1185	2844	423	3088	3511	2668	6179
SOP (t)		1400	1652	2663	4315		2629	2697	5307	8004	72	1707	1778	1860	3638	279	2574	2853	3693	6546	945	714	1659	1185	2844	423	3087	3510	2668	6179
SOP (%)		100	100	100	100		100	100	112	93	100	100	100	100	100	113	100	101	100	100	100	100	100	100	100	100	100	100	100	100

Total	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		5	7	0	7		10085	10349	0	10349	471	0	471	0	471	7115	0	7115	0	7115	465	0	465	59	524	1085	4997	6082	3224	9307
1		5666	10048	387	10435		12961	13337	0	13337	23818	13086	36905	199	37104	17057	9482	26538	406	26944	14954	16982	31936	9665	41601	28704	14941	43646	6177	49823
2		17396	27895	447	28342		2127	3397	101	3499	15868	17095	32963	811	33774	25639	46017	71656	18657	90313	14742	12054	26796	4918	31713	18626	23681	42307	12803	55110
3		13438	21997	10750	32748		12481	24234	4313	28547	1558	2802	4360	2423	6784	1948	11753	13700	12103	25803	11288	26925	38212	12319	50531	5840	10083	15924	13596	29519
4		1173	1939	13149	15088		4763	9729	11984	21713	98	866	965	3281	4246	101	596	697	2853	3550	2166	6044	8210	7144	15355	1394	1949	3344	4726	8069
5		137	260	3357	3618		379	957	4236	5193	0	735	735	4296	5031	8	9	17	2158	2175	33	607	640	2828	3468	250	330	579	1556	2136
6		19	36	1441	1477		88	224	1211	1435	0	234	234	1462	1697	1	0	1	1515	1516	0	79	80	1397	1477	96	139	236	1160	1396
7		17	35	853	887		44	111	308	419	0	36	36	714	750	1	0	1	622	622	0	0	0	1385	1386	28	19	47	907	955
8		11	22	714	736		18	45	85	131	0	19	19	575	594	1	0	1	582	582	0	0	0	1108	1108	31	28	59	952	1011
9		4	8	235	243		0	0	0	0	0	9	9	505	514	0	0	0	162	162	0	0	0	0	0	0	0	0	0	0
10		0	0	139	139		0	0	0	0	0	3	3	414	417	0	0	0	237	237	0	0	0	0	0	0	0	0	0	0
11		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	144	144	0	0	0	0	0	0	0	0	0	0
12		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	27	27	0	0	0	0	0	0	0	0	0	0
15+		0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total N	0	37866	62247	31473	93720	0	42947	62385	22238	84622	41814	34887	76700	14681	91381	51870	67856	119726	39465	159191	43650	62691	106341	40824	147164	56054	56170	112224	45100	157325
Catch (t)		7393	11939	15057	26997		9375	16182	10133	26315	6013	7750	13763	7801	21564	6506	14198	20704	12795	33499	8384	16211	24594	13766	38360	9515	11757	21272	13818	35090
SOP (t)		7393	11940	15057	26997		9375	16182	11121	27302	6014	7750	13764	7801	21565	6537	14199	20736	12795	33531	8383	16212	24595	13766	38361	9516	11757	21272	13818	35090
SOP (%)		100	100	100	100		100	100	110	96	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100

Table 2. Chub Mackerel. Catch numbers (%) -at-age by area for 2011-2016

Quarter 1	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1		7%	7%	0%	2%		3%	3%	0%	2%	12%	0%	6%	3%	4%	48%	5%	41%	0%	23%	25%	0%	3%	0%	2%	15%	0%	7%	0%	6%
2		41%	41%	0%	12%		22%	22%	0%	13%	77%	0%	39%	1%	16%	51%	85%	57%	4%	34%	71%	11%	17%	1%	12%	79%	9%	40%	10%	38%
3		49%	49%	13%	24%		64%	64%	10%	42%	10%	2%	6%	3%	4%	0%	10%	2%	6%	4%	4%	68%	62%	47%	57%	6%	69%	41%	22%	39%
4		3%	3%	22%	16%		8%	8%	43%	22%	1%	15%	8%	15%	12%	0%	0%	0%	11%	5%	1%	19%	18%	31%	22%	1%	17%	10%	13%	10%
5		0%	0%	24%	16%		1%	1%	31%	14%	0%	53%	26%	45%	38%	0%	0%	0%	20%	9%	0%	1%	1%	9%	3%	0%	3%	2%	14%	3%
6		0%	0%	11%	8%		1%	1%	9%	4%	0%	22%	11%	20%	16%	0%	0%	0%	25%	11%	0%	0%	0%	3%	1%	0%	1%	1%	13%	2%
7		0%	0%	13%	9%		0%	0%	5%	3%	0%	4%	2%	5%	4%	0%	0%	0%	7%	3%	0%	0%	0%	4%	1%	0%	0%	0%	13%	1%
8		0%	0%	12%	9%		0%	0%	2%	1%	0%	2%	1%	4%	3%	0%	0%	0%	6%	3%	0%	0%	0%	4%	1%	0%	0%	0%	15%	1%
9		0%	0%	4%	3%		0%	0%	0%	0%	0%	1%	1%	3%	2%	0%	0%	0%	6%	3%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10		0%	0%	2%	1%		0%	0%	0%	0%	0%	0%	0%	2%	1%	0%	0%	0%	9%	4%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	2%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15+		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Quarter 2	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
1		27%	27%	0%	22%		0%	0%	0%	0%	12%	21%	14%	0%	11%	14%	1%	9%	0%	7%	2%	0%	1%	0%	1%	7%	8%	8%	0%	5%
2		24%	24%	0%	19%		4%	4%	0%	3%	77%	48%	72%	0%	59%	84%	80%	83%	59%	76%	34%	11%	24%	0%	16%	54%	84%	69%	10%	51%
3		42%	42%	23%	38%		54%	54%	10%	42%	10%	9%	10%	6%	9%	2%	19%	8%	20%	11%	50%	68%	58%	34%	50%	28%	7%	18%	49%	27%
4		6%	6%	37%	12%		25%	25%	43%	30%	1%	7%	2%	25%	6%	0%	1%	0%	7%	2%	14%	19%	16%	32%	22%	8%	1%	4%	24%	11%
5		1%	1%	22%	5%		11%	11%	31%	17%	0%	11%	2%	47%	10%	0%	0%	0%	7%	2%	0%	1%	1%	14%	5%	2%	0%	1%	6%	2%
6		0%	0%	5%	1%		3%	3%	9%	5%	0%	3%	1%	15%	3%	0%	0%	0%	5%	1%	0%	0%	0%	6%	2%	1%	0%	0%	4%	1%
7		0%	0%	4%	1%		1%	1%	5%	3%	0%	0%	0%	3%	1%	0%	0%	0%	1%	0%	0%	0%	0%	8%	3%	0%	0%	0%	3%	1%
8		0%	0%	4%	1%		1%	1%	2%	1%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	6%	2%	0%	0%	0%	3%	1%
9		0%	0%	2%	0%		0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10		0%	0%	2%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15+		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Quarter 3	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		0%	0%	0%	0%		0%	0%	0%	0%	2%	0%	1%	0%	1%	22%	0%	9%	0%	7%	2%	0%	1%	0%	1%	1%	3%	2%	12%	5%
1		13%	13%	2%	9%		0%	0%	0%	0%	81%	34%	59%	0%	54%	41%	14%	25%	2%	20%	53%	46%	48%	55%	50%	70%	21%	52%	21%	42%
2		59%	59%	2%	39%		7%	7%	1%	6%	17%	52%	33%	3%	30%	32%	66%	52%	56%	53%	32%	25%	28%	24%	27%	24%	52%	34%	35%	34%
3		28%	28%	40%	33%		65%	65%	22%	56%	1%	11%	5%	15%	6%	5%	20%	13%	40%	19%	13%	26%	21%	19%	20%	5%	20%	11%	22%	14%
4		0%	0%	44%	16%		27%	27%	57%	33%	0%	3%	1%	20%	3%	0%	1%	1%	2%	1%	0%	3%	2%	1%	2%	1%	3%	1%	4%	2%
5		0%	0%	7%	2%		1%	1%	16%	4%	0%	0%	0%	20%	2%	0%	0%	0%	0%	0%	0%	1%	1%	0%	0%	0%	0%	0%	2%	1%
6		0%	0%	3%	1%		0%	0%	5%	1%	0%	0%	0%	7%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%
7		0%	0%	1%	0%		0%	0%	0%	0%	0%	0%	0%	9%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
8		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	9%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	1%	0%
9		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	9%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	8%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15+		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Quarter 4	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		0%	0%	0%	0%		43%	43%	0%	30%	2%	0%	0%	0%	0%	11%	0%	1%	0%	1%	0%	0%	0%	0%	0%	16%	24%	23%	4%	17%
1		5%	5%	0%	3%		55%	55%	0%	38%	81%	54%	55%	3%	39%	42%	23%	26%	0%	18%	56%	46%	53%	17%	41%	80%	53%	57%	15%	46%
2		29%	29%	0%	16%		2%	2%	1%	1%	17%	45%	43%	15%	34%	39%	67%	64%	13%	49%	29%	25%	28%	25%	27%	4%	8%	7%	36%	15%
3		55%	55%	30%	44%		1%	1%	22%	7%	1%	1%	1%	33%	11%	8%	9%	9%	25%	14%	14%	26%	18%	39%	25%	0%	11%	9%	27%	14%
4		10%	10%	46%	26%		0%	0%	57%	17%	0%	0%	0%	25%	8%	0%	0%	0%	24%	7%	0%	3%	1%	8%	3%	0%	3%	3%	7%	4%
5		1%	1%	11%	5%		0%	0%	16%	5%	0%	0%	0%	17%	5%	0%	0%	0%	16%	5%	0%	1%	0%	5%	2%	0%	1%	1%	3%	1%
6		0%	0%	6%	3%		0%	0%	5%	1%	0%	0%	0%	4%	1%	0%	0%	0%	8%	2%	0%	0%	0%	6%	2%	0%	0%	0%	3%	1%
7		0%	0%	4%	2%		0%	0%	0%	0%	0%	0%	0%	2%	1%	0%	0%	0%	6%	2%	0%	0%	0%	0%	0%	0%	0%	0%	2%	1%
8		0%	0%	3%	1%		0%	0%	0%	0%	0%	0%	0%	1%	0%	0%	0%	0%	6%	2%	0%	0%	0%	0%	0%	0%	0%	0%	2%	1%
9		0%	0%	1%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15+		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Total	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		0%	0%	0%	0%		23%	17%	0%	12%	1%	0%	1%	0%	1%	14%	0%	6%	0%	4%	1%	0%	0%	0%	0%	2%	9%	5%	7%	6%
1		15%	16%	1%	11%		30%	21%	0%	16%	57%	38%	48%	1%	41%	33%	14%	22%	1%	17%	34%	27%	30%	24%	28%	51%	27%	39%	14%	32%
2		46%	45%	1%	30%		5%	5%	0%	4%	38%	49%	43%	6%	37%	49%	68%	60%	47%	57%	34%	19%	25%	12%	22%	33%	42%	38%	28%	35%
3		35%	35%	34%	35%		29%	39%	19%	34%	4%	8%	6%	17%	7%	4%	17%	11%	31%	16%	26%	43%	36%	30%	34%	10%	18%	14%	30%	19%
4		3%	3%	42%	16%		11%	16%	54%	26%	0%	2%	1%	22%	5%	0%	1%	1%	7%	2%	5%	10%	8%	18%	10%	2%	3%	3%	10%	5%
5		0%	0%	11%	4%		1%	2%	19%	6%	0%	2%	1%	29%	6%	0%	0%	0%	5%	1%	0%	1%	1%	7%	2%	0%	1%	1%	3%	1%
6		0%	0%	5%	2%		0%	0%	5%	2%	0%	1%	0%	10%	2%	0%	0%	0%	4%	1%	0%	0%	0%	3%	1%	0%	0%	0%	3%	1%
7		0%	0%	3%	1%		0%	0%	1%	0%	0%	0%	0%	5%	1%	0%	0%	0%	2%	0%	0%	0%	0%	3%	1%	0%	0%	0%	2%	1%
8		0%	0%	2%	1%		0%	0%	0%	0%	0%	0%	0%	4%	1%	0%	0%	0%	1%	0%	0%	0%	0%	3%	1%	0%	0%	0%	2%	1%
9		0%	0%	1%	0%		0%	0%	0%	0%	0%	0%	0%	3%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
10		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	3%	0%	0%	0%	0%	1%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
11		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
12		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
13		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
14		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
15+		0%	0%	0%	0%		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%

Table 3. Chub Mackerel. Mean length (cm) -at-age by area for 2011-2016.

Quarter 1	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0																														
1		24.3	24.3		24.3		25.2	25.2		25.2	25.4		25.4	23.2	24.4	22.1	24.7	22.1		22.1	24.1	26.5	24.2		24.2	24.6		24.6		24.6
2		27.2	27.2	31.4	27.3		28.7	28.7	32.5	28.7	27.0		27.0	25.2	27.0	24.4	27.3	25.1	32.8	25.5	25.4	28.3	27.1	29.8	27.1	27.3	32.9	28.0	31.3	28.1
3		29.9	29.9	34.5	31.6		30.4	30.4	34.1	30.8	29.1	37.6	30.4	36.2	33.1	27.8	29.4	29.2	35.6	33.8	27.8	30.7	30.7	33.3	31.4	29.5	34.4	34.0	33.7	34.0
4		30.5	30.5	36.6	36.2		32.3	32.3	37.5	36.4	31.5	38.4	38.1	37.6	37.7		30.8	30.8	38.0	38.0	28.5	31.0	30.9	34.8	32.7	29.9	35.4	35.2	37.1	35.4
5				38.5	38.5		38.4	38.4	38.2	38.2		39.4	39.4	39.5	39.5				38.8	38.8		32.9	32.9	36.6	35.8	30.5	35.4	35.3	40.2	37.2
6				39.7	39.7		39.5	39.5	38.7	38.8		39.9	39.9	40.5	40.3				40.1	40.1				39.4	39.4		35.8	35.8	40.6	38.7
7				40.5	40.5		39.7	39.7	39.5	39.5		40.8	40.8	41.8	41.6				42.1	42.1				40.4	40.4		38.2	38.2	41.0	40.8
8				41.5	41.5		40.0	40.0	39.4	39.5		41.2	41.2	42.4	42.2				42.6	42.6				41.6	41.6		38.2	38.2	41.5	41.3
9				43.7	43.7							41.7	41.7	42.8	42.7				42.6	42.6										
10				45.4								42.5	42.5	43.8	43.7				42.3	42.3										
11																			42.9	42.9										
12																														
13																														
14																			43.5	43.5										
15+																														
Mean (cm)		28.5	28.5	38.7	35.6		30.2	30.2	37.6	33.3	27.1	39.5	33.2	39.1	36.8	23.3	27.4	24.0	39.9	30.8	25.2	30.5	30.0	34.9	31.5	27.1	34.5	31.2	37.8	31.7

Quarter 2	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0																														
1		21.2	21.2		21.2		25.8	25.8		25.8	25.4	24.0	25.0		25.0	23.9	25.0	23.9		23.9	25.6	26.5	25.6		25.6	25.1	25.4	25.3		25.3
2		27.3	27.3	32.5	27.3		30.2	30.2	32.5	30.2	27.0	27.0	27.0	30.3	27.0	25.6	29.3	26.9	29.8	27.5	27.2	28.3	27.4	33.5	27.5	27.8	27.5	27.6	32.1	27.9
3		30.6	30.6	35.0	31.1		32.2	32.2	34.1	32.3	29.1	30.7	29.4	35.8	30.2	29.8	30.2	30.2	31.5	30.9	29.3	30.7	30.1	34.5	31.1	33.4	30.3	32.9	34.3	33.7
4		33.2	33.2	36.2	34.9		35.5	35.5	37.5	36.3	31.5	35.8	34.4	37.1	36.4	32.2	30.9	31.0	36.8	36.1	29.4	31.0	30.2	36.1	33.2	35.5	31.2	35.2	36.4	36.1
5		36.6	36.6	37.5	37.3		37.6	37.6	38.2	37.9		38.4	38.4	38.7	38.6	34.5		34.5	37.9	37.9	33.4	32.9	33.0	37.8	37.4	35.8	32.0	35.6	37.3	36.9
6		37.9	37.9	38.6	38.5		38.2	38.2	38.7	38.5		39.2	39.2	39.6	39.6	41.5		41.5	39.4	39.4	37.2		37.2	39.2	39.2	36.4	35.7	36.4	38.3	38.0
7		39.6	39.6	39.4	39.4		39.0	39.0	39.5	39.3		39.5	39.5	40.7	40.6	41.5		41.5	40.8	40.8	41.0		41.0	40.1	40.1	38.3	37.5	38.2	39.3	39.2
8		40.4	40.4	41.9	41.7		38.9	38.9	39.4	39.2		40.2	40.2	41.8	41.7	41.5		41.5	41.6	41.6	42.2		42.2	40.9	40.9	38.3	37.5	38.2	39.4	39.3
9		42.5	42.5	46.1								41.1	41.1	42.4	42.4	41.5		41.5	41.6	41.6										
10				46.8								42.5	42.5	44.1	44.1	41.5		41.5	41.2	41.2										
11																41.5		41.5	42.3	42.3										
12																														
13																														
14																			43.5	43.5										
15+																														
Mean (cm)		27.6	27.6	37.2	29.4		33.8	33.8	37.6	34.9	27.1	29.0	27.4	38.4	29.4	25.4	29.5	26.9	32.0	28.4	28.5	30.5	29.4	36.6	31.9	30.1	27.6	28.8	35.2	30.8

Quarter 3	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		20.9	20.9		20.9						22.0		22.0		22.0	21.5		21.5		21.5	24.0		24.0	25.5	24.2	22.1	20.9	21.4	20.2	20.5
1		25.7	25.7	25.2	25.7		28.6	28.6		28.6	25.5	26.8	25.8	27.6	25.8	23.9	27.5	25.1	29.0	25.2	28.4	29.6	29.1	28.7	29.0	25.8	26.4	25.9	25.7	25.9
2		27.6	27.6	27.4	27.6		32.7	32.7	33.6	32.7	27.9	29.0	28.7	31.1	28.7	27.3	28.7	28.3	30.4	28.8	29.5	30.8	30.2	29.1	30.0	28.7	29.6	29.2	29.9	29.4
3		29.0	29.0	35.9	32.0		33.6	33.6	35.7	33.8	29.7	33.2	33.0	35.4	33.5	30.1	29.9	29.9	30.6	30.2	31.3	33.3	32.8	32.2	32.7	31.5	31.5	31.5	32.6	32.0
4		32.2	32.2	36.6	36.6		34.6	34.6	37.9	35.7		36.0	36.0	38.5	37.5	33.4	33.1	33.2	32.5	32.9	34.0	36.5	36.5	36.4	36.5	33.1	32.9	33.0	35.1	34.2
5		35.5	35.5	37.1	37.1		36.7	36.7	38.8	38.5		37.2	37.2	39.5	39.2	37.2	36.2	36.6	38.1	37.4	35.5	36.9	36.9	38.2	37.2	33.8	33.5	33.6	37.2	36.7
6				37.3	37.3		37.5	37.5	39.3	39.2		37.8	37.8	40.8	40.7	39.5		39.5	40.0	39.9		38.3	38.3	39.1	38.6	34.2	33.8	33.9	38.5	38.2
7				38.8	38.8				41.2	41.2		38.8	38.8	43.8	43.8	39.8		39.8	40.0	39.9									39.5	39.5
8				40.0	40.0							39.5	39.5	45.0	45.0	39.8		39.8	40.0	39.9						34.5	34.5	34.5	39.1	39.0
9				43.2										45.9	45.9															
10				44.0										46.5	46.5															
11																														
12																														
13																														
14																														
15+																														
Mean (cm)		27.8	27.8	36.0	30.7		33.8	33.8	37.6	34.6	25.8	28.9	27.2	40.5	28.4	24.8	28.8	27.2	30.5	27.9	29.0	31.1	30.3	29.6	30.1	26.8	29.1	27.6	29.2	28.1

Quarter 4	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		21.9	21.9		21.9		20.7	20.7		20.7	22.0		22.0		22.0	22.1		22.1		22.1	25.5		25.5		25.5	20.1	22.0	21.8	22.2	21.8
1		25.0	25.0		25.0		24.3	24.3		24.3	25.5	26.8	26.7	27.3	26.7	24.2	26.9	26.3		26.3	28.9	29.6	29.1	29.8	29.2	24.5	22.9	23.3	24.7	23.4
2		28.7	28.7	31.1	28.7		26.0	26.0	33.6	26.9	27.9	28.1	28.1	30.2	28.4	27.7	27.5	27.5	35.8	28.2	29.7	30.8	30.0	31.2	30.4	27.8	32.1	31.7	30.5	30.9
3		31.9	31.9	36.6	33.3		30.3	30.3	35.7	35.4	29.7	29.6	29.6	34.9	34.5	30.2	29.8	29.8	37.2	33.8	30.9	33.3	32.1	33.7	32.9		33.5	33.5	32.8	33.1
4		34.4	34.4	37.7	37.0		32.8	32.8	37.9	37.9				37.5	37.5	33.6	32.1	32.3	38.6	38.3	35.3	36.5	36.4	37.6	37.4		34.1	34.1	35.1	34.6
5		35.9	35.9	38.8	38.7		37.0	37.0	38.8	38.8				38.6	38.6	37.5		37.5	40.2	40.2	36.2	36.9	36.9	39.6	39.3		35.6	35.6	37.6	36.9
6		36.9	36.9	39.0	39.0		37.5	37.5	39.3	39.3				39.2	39.2	39.8		39.8	41.3	41.3		38.3	38.3	41.1	41.0		35.8	35.8	38.7	38.0
7		38.5	38.5	40.1	40.1				41.2	41.2				40.2	40.2	40.5		40.5	41.6	41.6							37.5	37.5	39.5	39.4
8		38.5	38.5	40.8	40.8									40.8	40.8	40.5		40.5	41.7	41.7							36.4	36.4	39.4	39.1
9				43.1										41.7	41.7															
10				44.3										42.8	42.8															
11																														
12																														
13																														
14																														
15+																														
Mean (cm)		30.8	30.8	37.8	33.9		22.8	22.8	37.6	27.2	25.8	27.4	27.4	35.6	29.9	25.8	27.6	27.4	38.7	30.7	29.4	31.1	30.0	33.5	31.1	23.9	25.1	24.9	31.1	26.6

Total	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		21.2	21.2		21.2		20.7	20.7		20.7	22.0		22.0		22.0	21.5		21.5		21.5	24.1		24.1	25.5	24.2	21.0	21.9	21.7	20.4	21.3
1		23.7	23.4	25.2	23.4		24.3	24.3		24.3	25.5	26.7	25.9	26.1	25.9	23.8	27.3	25.1	29.0	25.1	28.3	29.6	29.0	28.8	28.9	25.6	24.1	25.1	25.5	25.1
2		27.7	27.6	27.6	27.6		30.1	30.1	33.5	30.9	27.3	28.6	28.0	30.3	28.0	26.3	28.6	27.7	30.5	28.3	28.4	30.2	29.2	29.5	29.3	28.1	28.8	28.5	30.3	28.9
3		30.1	30.0	35.9	32.0		33.0	33.0	35.5	33.5	29.2	32.9	31.6	35.2	32.8	30.1	29.9	29.9	31.7	30.8	29.9	31.6	31.1	33.6	31.7	32.7	32.7	32.7	33.4	33.0
4		33.6	33.5	36.7	36.3		34.6	34.6	37.8	36.4	31.5	36.2	35.7	37.7	37.2	33.3	32.7	32.8	37.2	36.4	29.5	32.0	31.3	35.8	33.4	35.0	34.2	34.5	35.9	35.4
5		36.5	36.5	37.7	37.6		37.4	37.4	38.6	38.4		38.6	38.6	39.0	38.9	36.5	36.2	36.3	39.2	39.2	33.5	34.9	34.9	37.7	35.8	35.6	35.1	35.3	37.4	36.9
6		37.8	37.8	38.3	38.2		38.4	38.4	39.1	39.0		39.5	39.5	40.1	40.0	39.6		39.6	40.3	40.3	37.2	38.3	38.3	39.5	39.5	36.2	35.5	35.8	38.6	38.1
7		39.6	39.6	39.8	39.8				39.7	39.6		40.3	40.3	42.7	42.6	39.9		39.9	41.6	41.6	41.0		41.0	40.2	40.2	38.3	37.8	38.1	39.5	39.1
8		40.3	40.4	41.2	41.2				39.4	39.3		40.9	40.9	44.1	44.0	39.9		39.9	41.9	41.9	42.2		42.2	41.0	41.0	37.9	36.8	37.4	39.5	38.6
9		42.5	42.5	44.6								41.6	41.6	45.2	45.2	41.5		41.5	42.3	42.3										
10				46.1								42.5	42.5	46.1	46.1	41.5		41.5	42.0	42.0										
11																41.5		41.5	42.8	42.8										
12																														
13																														
14																			43.5	43.5										
15+																														
Mean (cm)		28.2	28.0	36.6	30.9		27.6	27.6	37.6	31.5	26.3	28.7	27.4	38.3	29.1	25.0	28.7	27.1	32.7	28.5	28.8	30.9	30.0	33.2	30.9	27.4	27.9	27.6	31.3	28.7

Table 4. Chub Mackerel. Mean weight (g) -at-age by area for 2011-2016.

Quarter 1	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0																														
1		111	111				135	135		135	128		128	92	112	83	118	84		84	110	147	111		111	117		117		117
2		159	159	255	255		202	202	291	202	156		156	125	155	115	162	126	274	134	129	183	160	220	162	162	303	180	254	181
3		221	221	350	350		239	239	338	249	197	470	239	417	321	169	199	195	352	307	169	241	241	316	260	204	349	339	329	339
4		233	233	427	427		293	293	449	417	250	505	494	473	478		228	228	425	424	183	248	248	368	301	212	385	380	456	388
5				505	505		485	485	475	475		552	552	560	558				450	450		302	302	434	405	227	387	383	597	465
6				562	562		529	529	496	499		578	578	607	600				496	496				549	549		402	402	619	533
7				601	601		536	536	527	528		624	624	679	669				574	574				595	595		501	501	639	626
8				654	654		547	547	524	527		643	643	713	701				595	595				653	653		501	501	669	655
9				771	771							669	669	736	728				595	595										
10				877	877							714	714	794	787				582	582										
11																			605	605										
12																														
13																														
14																			629	629										
15+																														
Mean (cm)		189	189	523	523		238	238	456	328	157	556	355	553	478	100	164	110	493	276	126	237	226	376	272	158	353	266	503	283

Quarter 2	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0																														
1		69	69		69		145	145		145	128	104	122		122	107	123	107		107	132	147	132		132	124	124	25		124
2		161	161	285	161		235	235	291	235	156	154	156	228	156	132	199	155	208	167	160	183	164	318	165	173	165	28	279	175
3		238	238	367	252		283	283	338	287	197	243	204	400	230	213	215	215	248	232	201	241	222	355	253	306	230	33	348	323
4		315	315	411	371		385	385	449	411	250	410	358	451	429	269	229	233	388	370	204	248	228	411	320	369	255	35	425	406
5		428	428	463	456		453	453	475	465		508	508	521	519	335		335	422	422	303	302	302	480	465	378	277	36	463	441
6		480	480	509	505		478	478	496	488		545	545	565	562	594		594	470	470	426		426	537	537	395	401	36	510	492
7		559	559	545	547		508	508	527	520		559	559	621	615	594		594	524	524	573		573	579	579	461	467	38	551	544
8		597	597	680	672		505	505	524	515		590	590	682	674	594		594	552	552	630		630	614	614	461	467	38	558	551
9		701	701	931								635	635	714	711	594		594	552	552										
10				973								712	712	810	809	594		594	538	538										
11																594		594	579	579										
12																														
13																														
14																			629	629										
15+																														
Mean (cm)		183	183	458	235		335	335	456	369	157	224	169	511	231	130	202	155	265	187	186	237	209	434	285	229	167	29	386	256

Quarter 3	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		67	67		67						82		82		82	76		76		76	109		109	142	113	83	87	21	79	80
1		138	138	129	138		219	219		219	129	176	142	193	142	108	184	133	220	135	184	229	210	209	210	135	178	26	166	145
2		178	178	176	178		333	333	359	334	173	222	209	277	209	163	215	201	258	214	208	260	237	220	233	188	251	29	261	235
3		211	211	453	318		361	361	437	367	210	341	334	414	350	219	244	240	262	250	247	337	316	304	313	253	302	31	338	311
4		308	308	483	481		393	393	522	437		428	428	527	489	305	340	335	323	330	317	448	445	446	445	292	344	33	420	382
5		430	430	505	505		473	473	564	550		474	474	569	558	425	451	441	541	493	364	463	463	519	474	313	364	34	499	479
6				515	515		505	505	586	583		500	500	630	625	509		509	624	605		521	521	558	534	324	373	34	555	543
7				596	596				676	676		537	537	787	785	521		521	624	610									597	597
8				660	660							568	568	856	855	521		521	624	610						333	395	35	584	580
9				864										912	912															
10				923										941	941															
11																														
12																														
13																														
14																														
15+																														
Mean (cm)		183	183	462	282		369	369	512	397	137	226	178	637	217	125	218	179	261	197	198	273	244	234	242	154	244	28	259	209

Quarter 4	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		77	77		77		81	81		81	82		82		82	83		83		83	129		129		129	64	101	22	104	97
1		127	127		127		132	132		132	129	176	172	186	173	111	171	159		159	191	229	203	233	207	115	115	23	147	118
2		207	207	273	207		166	166	359	188	173	204	203	254	210	171	186	185	439	205	210	260	226	271	240	170	321	32	276	287
3		298	298	483	354		263	263	437	427	210	237	237	395	382	222	241	239	498	378	239	337	290	348	319		364	33	343	353
4		388	388	535	504		341	341	522	522				489	489	312	307	307	560	549	359	448	441	496	483		385	34	421	403
5		449	449	596	588		485	485	564	564				531	531	438		438	643	643	388	463	461	582	568		437	36	517	491
6		496	496	608	606		505	505	586	586				558	558	523		523	696	696		521	521	652	648		443	36	564	537
7		574	574	665	665				676	676				604	604	552		552	715	715							509	38	601	597
8		574	574	708	708									630	630	552		552	723	723							465	36	594	584
9				860										673	673															
10				946										728	728															
11																														
12																														
13																														
14																														
15+																														
Mean (cm)		272	272	543	393		112	112	512	232	137	189	186	428	262	141	188	182	573	296	203	273	228	352	268	109	169	25	308	200

Total	2011					2012					2013					2014					2015					2016				
AGE	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All	9.a.S	9.a.N	9.a	8.c	All
0		70	70		70		81	81		81	82		82		82	77		77		77	110		110	142	114	72	100	95	81	90
1		107	102	129	103		132	132		132	129	173	145	160	145	107	179	133	220	134	182	229	207	210	208	132	134	133	162	136
2		178	177	179	177		277	277	357	279	161	213	188	255	190	145	206	184	250	198	185	242	211	229	214	178	215	199	266	214
3		238	234	446	304		339	339	426	352	198	329	282	401	324	219	239	236	292	263	215	275	257	332	276	287	322	309	344	325
4		345	336	481	462		389	389	510	456	250	432	414	488	471	303	321	319	475	445	205	284	263	403	328	354	368	362	424	398
5		432	430	507	502		458	458	532	519		522	522	541	538	403	451	428	536	535	306	383	379	478	447	370	399	387	490	462
6		482	481	540	539		483	483	555	543		560	560	590	586	514		514	558	558	426	521	520	557	555	391	419	407	542	519
7		560	559	602	600		511	511	548	538		600	600	729	723	525		525	661	661	573		573	582	582	461	503	478	583	573
8		596	596	674	671		509	509	524	519		627	627	807	801	525		525	683	683	630		630	624	624	450	468	459	584	568
9		701	701	855								661	661	870	867	594		594	583	583										
10				943								714	714	921	919	594		594	569	569										
11																594		594	599	599										
12																														
13																														
14																			629	629										
15+																														
Mean (cm)		195	192	478	288		259	259	500	323	144	222	179	531	236	126	209	173	324	211	192	259	231	337	261	170	209	190	306	223